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DYNAMICAL TERMINOLOGY.

THE poundal is being still discussed in the pages of the *Engineer*. Mr. Deeley makes a suggestive remark as to weight and mass when he says that at the centre of the earth a mass of a pound of lead and a pound of aluminium have no weight; but, all the same, they will trap a man's fingers if moved together upon them. This conveys the idea of difference as between mass and weight; of course, even where the mass of 1 lb. does not weigh 1 lb., the same force is required to communicate unit motion to it as where it does weigh 1 lb. The professors realise this, and want engineers to do the same. Perhaps engineers do realise it, but for all their purposes such ideals are useless.

As "Sextus" writes, every new professor invents a new terminology. We might all do so, and when we see all this ado about nothing, we feel inclined to invent terms ourselves. Thus the "profee," derived from professor, might indicate the fee paid to any of that ilk for work done by a batch of students, and the "fee pro" might similarly represent the sum paid by the student for the privilege of doing the work.

The foot-pound and the square inch are, writes Sextus, good enough for engineers, and he suggests that professors should mind their own business. Mr. Harrison complains that the professors who ought to know all, have no real knowledge of facts, nor can they agree on anything, and thus no one pays them any deference.

Mr. Harrison will have it that we really know nothing. We don't know why a train continues to run after the moving force is discontinued. We don't know why g is not more or less than 32·2. We don't know, in fact, why matter cannot take on motion or throw it off instantly. We feel like suggesting that the reason is that matter may be suitable to make fly-wheels from, but we are confident this explanation will not do for everyone. It represents a very useful practical use of inertia.

Momentum on paper is $m\,v$, but in real life is $m\,v^2$. How does Mr. Harrison make this out? He asks for an intelligent teaching of dynamics. He looks on dynamics as he does on classics—merely a mind training. Why, he asks, do professors attach so much importance to knowledge which the engineer says is of no use to him? He compares the professor's attitude to the presentation of a tenon saw to a cheesemonger as a better cutting tool than a slice. It may be, but the cheesemonger will have none of it. Finally, he asks Mr. Deeley, or any other poundal man, to state definitely where lies the advantage of this, and he asks everyone to define what they mean by the words they use, and the benefits they expect to accrue from each new term they would have adopted. "X.," from Nottingham, must be trying to be funny when he asks for an explanation of the benefit to be derived from marking his pressure gauges in poundals instead of pounds per square inch. Mr. Deeley will be able to crush "X" if he takes him seriously. The

one apparent fact visible in this correspondence is that no one seems agreed upon anything, or if agreed, they are not able to converse in the same language.

THE TELEPHONE MANAGER.

"Electrical Engineering" (U.S.), in its current number, devotes considerable attention to telephone subjects, recording the introduction in a local exchange of "a modern telephone plant," including "the latest type of Western Electric branch multiple board." An article on "Telephone Toll Lines" commences with the statement that "properly constructed, telephone toll lines are expensive to build, costly to maintain, and rarely prove productive investments"; and, later, proceeds to say that "yet the telephone toll line is an absolute necessity to the success of every exchange. For as a town isolated from other towns is of little general importance until connected with the outside world by means of rapid communication, so the importance of a telephone exchange, isolated from communication with other exchanges must necessarily remain at a minimum." But perhaps the article of most general interest is that entitled "The Telephone Manager," with sub-headings such as "an inviting field for young men." We wonder whether the same observation would apply here? The requirements are certainly varied. "The manager of the modern telephone exchange must be an active man of affairs, must keep in touch with the latest approved methods of telephone construction and operation, must be broad minded, congenial, capable of exercising tact in winning the goodwill of the best elements in the community, and sufficiently diplomatic to straighten out the differences of opinion that may arise in the minds of customers regarding the cost, the nature, or quality, of the telephone service supplied." Differences of opinion! Are there, then, any differences? The telephone manager who is conversant with all the details should easily explain to a complaining customer how a conversation came to be interrupted; could readily portray to the head of a large establishment how tremendous is the pressure of calls at certain hours, and show the necessity of a second telephone!! and by his tact and knowledge cause a fault-finding customer "to investigate the method of using the telephone at his own establishment, and to understand how to correct any wrong methods that may have been unwittingly practised." On the whole, it would seem that the position of telephone manager would be found a most suitable one for the budding diplomatist. He should be able to turn unpromising material to profitable account, and with reasonable practice succeed in demonstrating the whiteness of black. Let us hope that the reward is equal to the service.

An Association Wanted.

Mr. S. F. Walker is now growling for an Association to control prices, to keep up wages for electrical engineers, and to discourage youngsters. Why not leave the youngsters alone to lose their own or their friends money if they thereby gain experience at the cost of themselves. All the trouble in the electrical business does not come from wilful competition. It is largely due to ignorance, and comes from an insufficient knowledge of estimating commercial costs. Thus there is interest on capital and expenses of management and rent, taxes and depreciation to be all charged upon costs of manufacturing before any margin can be shown. But these items are too frequently neglected. Only recently the writer was engaged in getting out the costs of certain manufacturing operations. A certain figure was arrived at for material and labour. This figure was doubled when clerical and management expenses were added together with rent, taxes, and sundries. Then we may sometimes find that serious errors are made in estimating the losses due to waste. Thus a substance loses one-third in waste, and we have known this allowed for by adding one-third to the cost of the raw material and calling the sum the cost of the finished material. Now every man knows who has any experience, or would go carefully into simple figures, that a wastage of one-third increases the cost of the finished article by one-half. Yet an experienced man, who did know better, recently tried to force a contract on a young man upon this very basis, urging that he was actually allowing an extra 16 per cent. when he allowed 50 per cent. in price for a wastage of a third. These are very simple things, yet they and others similar have had much to do with the competition in electrical business which rouses the ire of the correspondent of the *Electrical Engineer*. The Association which Mr. Walker demands would, he says, place the electrical engineer in his proper position, to wit, at the head of the scientific professions. We wonder where in the head Mr. S. F. Walker himself would be found placed, and how some of the other professions would look upon the horde of electrical engineers thus taking the lead of them all. There is and can be no leading profession. Judged by salaries, that of ballet dancer would be an easy first. This is not the day of Guilds and closed associations, and every man, no matter what he may be, must simply make his own name apart from any association he may be in.

Prevention of Vibration in Steamships.

A letter in *Engineering* from Mr. J. S. Raworth suggests an idea for curing vibration which is worth trying. When travelling in a twin screw steamer the vibration is periodic, and only occurs when the engines of the two screws are at a certain relative crank angle, while at another phase the vibration disappears altogether. Mr. Raworth would fix this latter phase, and his suggestion for accomplishing this is, that the nuts of the screw reversing gear of the two engines should be coupled by rods controlled by a hydraulic cylinder actuated by a differential gear of the Jack-in-the-box type in connection with both engines. The engineer watches for the period of no vibration, and closes the clutch which couples the controlling valve to the differential gear. Obviously, as one engine tries to overrun the other, the link motions will be put the one forward the other backward, and the non-vibration phase will be maintained. Obviously, as suggested, by Mr. Raworth, a dozen methods might be followed to secure the required end. The simplest would, perhaps, be gearing with a clutch upon the screw shafts to absorb the difference of turning effort of the two engines and keep them together. Mr. Raworth's suggestion would certainly prove effectual in all cases where vibration is noted to be periodic, and it would enable the relative crank angles to be ascertained at different rates of revolution, and perhaps throw some light upon the whole question of balancing moving parts, steam pressures, &c., and of inertia action.

ELECTRICAL POWER TRANSMISSION IN FACTORIES.

Continuing this paper of Mr. D. C. Jackson,* it is to be noted that the author states that for plants not less than 100 H.P., it is a misfortune for a new manufacturing establishment, except under special or exceptional conditions, not to be electrically equipped. Such equipment ought to be so arranged that the crane motors can be operated from the general transmission wires, and the generators ought also to be adapted for the factory lighting; this latter seems important as an economy of outlay. These conditions are filled by a 220-volt continuous current system with compound wound generators, or by a polyphase alternating current system. As a rule, the former promises best in an average place. The voltage of 220 is usable by the incandescent lamps directly connected between positive and negative transmission wires or four arc lamps can be similarly interposed.

In already existing works the arrangements will be more complex. In heavy works electrical cranes are so desirable, that at the same time the general driving may well be undertaken. This change is said by the author to be invariably economical. Where economy comes in may, perhaps, appear doubtful, but a moment's consideration of the possibility of putting a machine tool at any angle, and in any convenient corner, the consequent abolition of half or quarter-turn belts, the saving of room now filled by belts to the detriment of crane arrangements and similar smaller factors, all multiply to a respectable aggregate. Tests are instanced where the saving in attendance, belts, &c., and repairs alone nearly pays interest on the change, apart from any consideration of the position of tools, less stoppages and better lighting. The driving of a distant and isolated building occurs as a very suitable case for electrical transmission, and the saving which can then be made in either the abolition of the separate steam plant, or of long lines of shafts or ropes is very marked.

Then there are places where the transmission losses are fully 70 per cent. of the engine power, and the place has outgrown its power. The cost of installation has been great, and deterred change so long as the power was sufficient to drive all the load. Growth, however, has brought a crisis, and the cost of altering the old system is nearly, or fully, as much, as making the change to electricity. In such cases electricity will go in and show of what it is capable in the way of economy.

The author sums up to the effect, that in new works the extra cost of electricity is small as compared with the economy it will secure. In other places the advantages of changing to electricity outweigh the first cost, while in others the irregular arrangements of the buildings and similar items enable electricity to step in with advantage.

In arranging motors, it is best to give one to each large tool, and group smaller tools upon a minimum size of motor of 3 to 5 H.P., or a maximum of 10 to 15 H.P. Obviously each case must stand very much by itself, and herein, we would remark, comes in the intelligence of the practical engineer to scheme out the best arrangement, remembering not to carry out the separate motor idea to an excess, but where numerous small machines exist in line upon a bench, for example, to drive them from a line shaft. The division of a long line of shafting of, say, 100 feet in length, into four lengths of 25 feet each, driven at its centre, reduces the strength of the shaft to one-eighth what was previously required. Thus a 3-inch shaft tapering down to the usual minimum of $1\frac{1}{2}$ would be replaced by short lengths having a maximum diameter of $1\frac{1}{2}$ inch, and therefore of about three-sevenths the weight of the large stepped driven shaft of four diameters varying by half an inch per step. Being of only three-sevenths the weight, and of an average diameter of two-thirds the loss by friction, would be only two-sevenths. The loss by want of correct alignment would probably be a tenth, or even less, that of the stiff long shaft. Then the oil required would be certainly less than two-sevenths, and the expense of the shafting would be about half, and of the bearings about two-fifths, as anyone can see who consults a price list of millwright goods. This, moreover, does not include the carriers, which will be correspondingly lighter in weight. In the discussion which followed on the paper, the merits of polyphase motors were attended to by Mr. Coster, who considered they were superior to direct current machines. They had no brushes, had a higher efficiency at partial load, and have no limit of distance within 15 or 20 miles, an item, however, that will only have effect in a few cases of long transmission *to* a works, and not much weight in transmission *within* a works. Mr. Arnold inclined to support the author that for ordinary regular running the direct current was preferable. He also considered that in a plant of over 150 H.P. it would pay to produce current rather than to buy from outside. One reason of this is that the engine steam will serve to warm the building. A kilowatt hour at the switchboard, with coal at $3, can be produced for $\frac{3}{4}$d. How, then, can it pay to buy at $2\frac{1}{2}$d. or $3\frac{1}{2}$d. Adding wages, the producing cost will only be a half, or thereabouts.

Mr. Gibbs deprecated direct gearing of motors in lathes and tools. He thought they ought to have a short belt to give elasticity, and besides it enabled high speed and smaller motors to do the work, and so saved first cost. The use of motors without any gearing he looked on as an absurdity from an economic point of view. The same speaker also stated that the cost of repairs to 140 motors in a works of 1,500 H.P. was less than the former cost of repairs to belts, while the gain in appearance was most striking, and must be seen to be credited.

In some shops he knew, driven half by electricity and half by belts, the difference was very satisfactory to electricity. The gain in appearance was marvellous, and must be seen to be appreciated.

A case was also presented of a cotton rope driven walking crane, which absorbed 15 H.P. to "idle" the rope along, and only 2 horse additional when lifting or traversing. Two 3-H.P. motors now attend to this crane, and in a year they estimate the saving will pay for the cost of the change.

* See page 195, Electrical Review for February 12th.

DESIGN OF DIRECT CURRENT MOTORS.

It is known that a well designed dynamo can be used as a motor, and in consequence, the subject of motor design has received but little attention, it being often considered that the theory of the design of generators includes that of motors also. If a machine is primarily intended for use as a motor, there are, however, differences in the design which should be attended to. The general calculation of the motor will be the same as that of a generator provided that, when run as a motor, it gives the required power at the proper speed. Following Mr. A. E. Wiener*, we propose to indicate the method of these calculations.

Consider any direct current machine, either generator or motor. When run as a generator, let

p_1 = output in watts;
p^1_1 = watts developed in its armature;
then $p_1 = \eta_1 p^1_1$, (1)

where η_1 is the electrical efficiency of the machine.

If the machine is run at the same speed as a motor, the power absorbed within its armature will be p^1_1; let its output as a motor be p_2, then

$$p_2 = \eta_2 p^1_1, \quad (2)$$

where η_2 is the gross inefficiency of the machine, or the ratio between the power absorbed in the armature to the mechanical power developed.

If further, p_3 = power supplied to the machine run as a generator, and p_4 = power supplied when run as a motor,

we have $$p_3 = \frac{p^1_1}{\eta_2} \quad (3)$$

and $$p_4 = \frac{p^1_1}{\eta_1} \quad (4)$$

From equation (2) we see that if we want a motor having an output of p_2 watts, the design will be similar to that of a generator which will, at the same speed, develop $\frac{p_2}{\eta_2}$ watts.

* The *Electrical World*, pp. 693-4 and pp. 725-6. December, 1896.

If E is the voltage between the motor terminals, the E.M.F., E^1, developed by the machine run as a generator is given by the equation

$$E^1 = E - i(r + r^1) \qquad (5)$$

where i is the current passing through the armature, r the resistance of the armature, and r^1 the resistance of the series field coils.

Equation (5), though sufficient for our purpose, is not strictly true for generator and motor alike. For the same excitation, speed, and armature current the counter E.M.F. of a motor is greater than the E.M.F. of the machine when run as a generator. There is less armature reaction in the motor than in the generator, and, whereas, the counter E.M.F. of the motor is strengthened by the self-induction of the armature, the E.M.F. of the generator is weakened.

The current, i, in equation (5) is obviously given by

$$i = \frac{p^1_1}{E^1} \qquad (6)$$

To obtain the drop of volts, due to internal resistances, and the efficiencies, we must have recourse to tables compiled from tests of machines of different capacities. These data are purely empirical, and are given in Tables I. and II., which are taken from Mr. Wiener's paper referred to above.

Table I.

Capacity in kilowatts.	Drop of volts due to armature resistance, &c., in per cent. of E.M.F. at machine terminals.		
	Shunt machines.	Series machines.	Compound machines.
Up to 0·5	20 to 12	40 to 25	30 to 20
„ 1	12 „ 10	25 „ 20	20 „ 15
„ 2·5	10 „ 8	20 „ 16	15 „ 12
„ 5	8 „ 7	16 „ 14	12 „ 10
„ 10	7 „ 6	14 „ 12	10 „ 8
„ 25	6 „ 5	12 „ 10	8 „ 7
„ 50	5 „ 4	10 „ 8	7 „ 6
„ 100	4 „ 3·5	8 „ 6	6 „ 5
„ 200	3·5 „ 3	6 „ 5	5 „ 4
„ 500	3 „ 2·5	5 „ 4	4 „ 3
„ 1,000	2·5 „ 2	4 „ 3	3 „ 2·5
„ 2,000	2 „ 1·5	3 „ 2·5	2·5 „ 2

Table II.—Average Efficiencies for Motors of Various Sizes.

Output in kilowatts.	Electrical efficiency. η_1	Gross efficiency. η_2	Commercial efficiency. $\eta_3 = \eta_1 \times \eta_2$	Power absorbed in armature in kilowatts.
0·37	0·75	0·80	0·60	0·5
0·75	0·82	0·82	0·67	0·9
1·5	0·85	0·84	0·72	1·8
3·73	0·87	0·86	0·75	4·0
7·46	0·89	0·88	0·78	8·5
11·2	0·90	0·89	0·80	12·6
14·9	0·91	0·90	0·82	16·6
18·65	0·92	0·91	0·84	20·5
22·4	0·93	0·92	0·86	24·5
29·8	0·94	0·93	0·87	32
37·3	0·945	0·935	0·88	40
56	0·95	0·94	0·89	60
74·6	0·955	0·9425	0·90	80
112	0·96	0·945	0·91	118
149	0·97	0·9475	0·92	158
224	0·98	0·95	0·93	236
298	0·9825	0·9525	0·935	318
373	0·985	0·955	0·94	391
559	0·9875	0·9575	0·945	585
746	0·99	0·96	0·95	777

Calculation of Speed.

The speed of a dynamo-electric machine depends upon (1) the load; (2) the resistance of the armature and series field windings, and (3), upon the excitation of the field magnets.

If a machine is run as a generator at a speed of n_1 revolutions per minute, and generates E^1 volts in its armature, and E volts at the brushes, then

$$E^1 = E + i(r + r^1) \qquad (7)$$

where i, r, and r^1, have the same meanings as in equation (5).

If the machine is run as a motor with the same current through its armature, the counter E M.F.$_1$, E_1, is given by

$$E_1 = E - i(r + r^1), \qquad (8)$$

and its speed, n_2, is given by

$$n_2 = \frac{E_1}{E^1} n_1$$

$$= \frac{E - i(r + r^1)}{E + i(r + r^1)} n_1, \qquad (9)$$

the potential difference between its terminals being the same as when run as a generator. Also if N is the number of conductors on the armature, x, the number of pairs of armature circuits in parallel, and F the useful magnetic flux, then

$$E_1 = \frac{F\,N\,n_2}{60 \times 10^8\, x}$$

and the current, i, is given by

$$i = \frac{E - E_1}{r + r^1}$$

$$= \frac{E - \dfrac{F\,N\,n_2}{60 \times 10^8\, x}}{r + r^1} \qquad (10)$$

The power expended is the product

$$E_1\, i,$$

and is also equal to the product of the angular velocity of the armature and the torque; that is, it equals $2\pi n_2 \tau \times \frac{746}{33{,}000}$ watts, where τ is the torque in foot-pound units. Hence we get

$$E_1\, i = 2\pi n_2 \tau \times \frac{746}{33{,}000}$$

or

$$\frac{F\,N\,n_2}{60 \times 10^8\, x} \times \frac{E - \dfrac{F\,N\,n_2}{60 \times 10^8\, x}}{r + r^1} = 2\pi n_2 \tau \times \frac{746}{33{,}000}$$

whence

$$n_2 = \frac{60 \times 10^8\, x}{F\,N} \cdot E - 0{\cdot}142 \left(\frac{60 \times 10^8\, x}{F\,N}\right)^2 \times \tau (r + r^1) \qquad (11)$$

Equation (11) shows that if $r + r^1$ is negligible, or if $\tau = 0$ (light load, neglecting friction), then

$$n_2 = \frac{60 \times 10^8\, x}{F\,N} \cdot E.$$

The value of τ in foot-pound units is given by the equation

$$\tau = \frac{11{\cdot}74}{10^{10}} \frac{i\,N\,F}{x} \qquad (12)$$

The Calculation of Current.

The current in the armature of a motor for any load is given by the equation

$$E\,i = P + i^2(r + r^1) + P_0 \qquad (13)$$

where E = potential difference between the terminals of the motor;

P = useful output of motor.

and P_0 = energy required to drive motor when running light.

Solving equation (13) as a quadratic in i, we get

$$i = \frac{E - \sqrt{\{E^2 - 4(r + r^1)(P + P_0)\}}}{2(r + r^1)} \qquad (14)$$

In the case of a shunt motor $r^1 = 0$, and equation (13) takes the form

$$i = \frac{E - \sqrt{\{E^2 - 4r(P + P_0)\}}}{2r} \qquad (15)$$

Current for Maximum Efficiency.

It is of importance to know for what value of the current the efficiency of the motor will be a maximum. This can be determined as follows:—

Total output of motor $= E\,i - i^2(r + r^1)$
Useful „ „ $= E\,i - i^2(r + r^1) - P_0$
Total input of motor $= E\,i + P^1$.

where P^1 = power absorbed in the shunt coils.

The commercial efficiency is therefore given by

$$\eta_3 = \frac{E\,i - i^2\,(r + r^1) - P_0}{E\,i + P^1} \qquad (16)$$

and the electrical efficiency by

$$\eta_1 = \frac{E\,i - i^2\,(r + r^1)}{E\,i + P^1} \qquad (17)$$

Expressing the condition $\frac{d\,\eta_3}{d\,i} = 0$, we see that η_3 is a maximum when

$$i = \sqrt{\left\{\frac{P^1 + P_0}{r + r^1} + \left(\frac{P^1}{E}\right)^2\right\}} - \frac{P^1}{E} \qquad (18)$$

Similarly the condition $\frac{d\,\eta^1}{d\,i} = 0$, leads to the equation,

$$i = \sqrt{\left\{\frac{P^1}{r + r^1} + \left(\frac{P^1}{E}\right)^2\right\}} - \frac{P^1}{E} \qquad (19)$$

Application of Method.

We will now apply the above theory to the calculation of a particular case.

Take the case of a shunt motor whose output is to be 10 kilowatts and which is to run from a 200 volt circuit, and suppose that the number of pairs of armature circuits in parallel is 2. By reference to Table II. we see that $\eta_1 = 0{\cdot}9$ and $\eta_2 = 0{\cdot}88$. Suppose, further, that the motor is required to run at a speed of 1,200 revolutions per minute; that is, $n_2 = 1{,}200$.

From equation (2) we get

Total power absorbed in motor armature $= p^1_1$

$$= \frac{p_2}{\eta_2}$$

$$= \frac{10{,}000}{\cdot 88} \text{ watts.}$$

$$= 11{,}364 \text{ watts.}$$

Now, using equation (1) we see that the output, p_1, of the machine run as a generator is given by

$$p_1 = \eta_1\,p^1_1$$

$$= 0{\cdot}9 \times 11{,}364$$

$$= 10{,}227 \text{ watts.}$$

The power required to drive the motor is, by (4)

$$p_4 = \frac{p^1_1}{\eta_1}$$

$$= \frac{11{,}364}{0\,9}$$

$$= 12{,}627 \text{ watts.}$$

From Table I. we find that the percentage drop of volts due to internal resistances is from 6 to 7. Taking 6·5 as an average, the drop of volts in the present case is 13, that is $i\,r = 13$. [In the present case $r^1 = 0$.]

The E.M.F. developed in the armature of the corresponding generator is by (5)

$$E_1 = 200 - 13 = 187 \text{ volts,}$$

with a current, by (6), equal to

$$i = \frac{11{,}364}{187} = 66 \text{ amperes,}$$

at a speed, by (9), given by

$$n_1 = \frac{200 + 13}{200 - 13}\,n_2$$

$$= \frac{213}{187} \times 1{,}200$$

$$= 1{,}366 \text{ revolutions per minute.}$$

The resistance, r, of the armature is given by

$$i\,r = 13$$

or

$$r = \frac{13}{66} = 0{\cdot}197 \text{ ohms.}$$

If now we assume that the motor has 374 armature conductors, we find from equation (10) that

$$\frac{F \times 374 \times 1{,}200}{60 \times 10^8 \times 2} = 200 - 13 = 187$$

or

$$F = \frac{187 \times 60 \times 10^8 \times 2}{374 \times 1{,}200}$$

$$= 5{,}000{,}000 \text{ C.G.S. line of force,}$$

and the torque is, by (12), given by

$$\tau = \frac{11{\cdot}74}{10^{10}} \times \frac{66 \times 374 \times 5 \times 10^6}{2}$$

$$= 72 \text{ foot-pounds.}$$

By equation (11) we see that the speed of the motor running light is

$$n^1_2 = \frac{60 \times 10^8 \times 2 \times 200}{5 \times 10^6 \times 374}$$

$$= 1{,}283 \text{ revolutions per minute,}$$

and at full load ($\tau = 72$)

$$n_2 = 1{,}283 - 0{\cdot}142 \left(\frac{60 \times 10^8 \times 2}{5 \times 10^6 \times 374}\right)^2 \times 72 \times 0{\cdot}197$$

$$= 1{,}283 - 83$$

$$= 1{,}200$$

The above calculation of the speed running light neglects the torque necessary to overcome friction. If we know the power required to drive the motor against friction only the speed at no load may be more accurately calculated. Suppose this power to be 800 watts, the no load current will then be given be

$$i_0 = \frac{800}{200} = 4 \text{ amperes;}$$

and the friction torque will be

$$\tau_0 = \frac{11{\cdot}74}{10^{10}} \times 20 \times \frac{374}{2} \times 5 \times 10^6$$

$$= 22 \text{ foot pounds}$$

and the no load speed is

$$n^1_2 = 1{,}283 - 25$$

$$= 1{,}258 \text{ revolutions per minute.}$$

Thus the speed varies 5 per cent. between no load and full load.

Current for Maximum Efficiency.

By means of equation (17) we find that the power absorbed in the shunt coils is 513 watts.

The current in the shunt is therefore

$$\frac{513}{200} = 2{\cdot}565 \text{ amperes,}$$

and the resistance of the shunt windings is given by

$$R = \frac{513}{(2{\cdot}565)^2}$$

$$= 78 \text{ ohms.}$$

The commercial efficiency is a maximum, by (18), when

$$i = \sqrt{\left\{\frac{513 + 800}{0{\cdot}197} + \left(\frac{513}{200}\right)^2\right\}} - \frac{513}{200},$$

$$= 79 \text{ amperes (nearly).}$$

The electrical efficiency is, by (19), a maximum when

$$i = \sqrt{\left\{\frac{513}{0{\cdot}197} + \left(\frac{513}{200}\right)^2\right\}} - \frac{513}{200},$$

$$= 48{\cdot}5 \text{ amperes.}$$

The calculations are now as complete as we can make them from the paper referred to above.

We have purposely changed the data and order of calculation, because the illustration in Mr. Wiener's paper does not appear to bring out completely the capabilities of his theory. Some data which he has assumed are capable of calculation.

Perhaps the greatest omission in the paper is the small amount of attention given to motors compounded to run at constant speed under a variable load. We are told that a compound-wound motor will maintain its speed perfectly constant under all loads, if the series winding is properly adjusted, but no attempt is made to calculate the constants of the shunt and series coils. Such a calculation can be made to a first approximation.

REVIEWS.

Submarine Cable Laying and Repairing. By H. D. Wilkinson, M.I.E.E. London: The *Electrician* Printing and Publishing Company, Limited, Salisbury Court, Fleet Street, E.C.

(Continued from page 307.)

We will now deal with Mr. Wilkinson's matter on methods of testing, and in doing so here, it is necessary to again point out that we are reviewing this book in the order of the subject, rather than in the extraordinary order in which the matter is arranged. First of all, then, with regard to the battery, on page 221 the author says: "The most simple and reliable methods of measuring the internal resistance of a battery are Mance's bridge method, and the half deflection method." The latter is certainly peculiarly simple, but also in many cases peculiarly inaccurate. To arrive at the true resistance of a battery, it is above all things important that the electromotive force shall remain constant throughout the test. All other methods of testing battery resistance, except those of Munro, Kempe, and Muirhead, put a heavy strain on the battery, the result being a fluctuating E.M.F. None of these methods are described in this book. Muirhead's is probably the best, and most generally used for testing Leclanché cells. These are invariably employed for testing high resistance circuits, such as require to be dealt with in cable work.

Some confusion, or misunderstanding, shows itself on page 311, where the author says: "The tests on shore are all made with *cable* immersed in water at the standard temperature of 75° F., to which all subsequent tests are referred. These tests are usually spoken of as the "seventy-fives." The italics are ours. Mr. Wilkinson must be thinking of the tests made on each drum of *core* after manufacture. Here each drum is placed in water, maintained at 75° F., the standard temperature for purposes of after comparison by reduction of values to this temperature. These are termed the "seventy-fives."

The tests on the "running" or completed sections of cable under water are made at the existing temperature in the cable tank—anything, say, from 40° to 70°—the results being reduced from the observed or calculated temperature to 75° F. by means of the coefficient table. The variation in the resistance of gutta-percha by temperature was first determined by Messrs. Bright and Clark during the core tests on the Persian Gulf cable of 1863. A little later on a corresponding temperature coefficient table was drawn up for Hooper's rubber. On page 75, when speaking of tests aboard ship, the author says: "The earth terminal in the testing room is usually connected by a wire to one of the iron girders of the ship." He might also have added it is usually in addition—and with more point—connected to each cable tank and to all sheathing wires of each section.

With reference to the ordinary discharge (or charge) method of measuring the capacity of a completed section of cable (page 240) the author states: "The apparent capacity of these sections is found to be greater than the sum of the capacities of the core length." The reverse is, however, usually the case, partly no doubt owing to the magnetic induction of a coiled iron sheathed cable. Fig. 128 shows the correct way of testing a cable by direct throws under such circumstances, and here the results often come out remarkably accurate even for considerable lengths, though they would be a long way far from the truth in a straight laid cable. It would seem as though the magnetic induction introduced in a coiled cable about balances the error due to the resistance and consequent retardation of any considerable length when testing by throws.

What is now commonly known as "Gott's test" for determining the capacity of a laid cable, is well described in this book, and its special characteristic features pointed out. Moreover, Muirhead's correction for absorption is even better expressed than had ever been done by the deviser himself. This was also very clearly put by Mr. Arthur Dearlove in the *Electrician* some years ago.

The author gives us an introductory chapter which, for some reason or another, is *entirely electrical*, and, moreover, almost exclusively with reference to fault testing. On page 3 of this he says: "But it frequently happens during repairs in deep water or rough weather that a bridge test is limited to a minute *or 30 seconds*, on account of the dangerous strain on the cable when both ends are hanging to the ship." The italics are ours. In the first place it should be remarked that cables are not ever intentionally picked up in rough weather, though it sometimes happens that the latter supervenes during the operation. Secondly, we consider a minute would be the least time which would be of any use even for taking the roughest possible conductor resistance test, and that under the most favourable conditions—*i.e.*, a comparatively short length and freedom from strong and variable earth currents. Regard must be had for the fact that in measuring the C R of anything like a long cable, a large part of a minute must elapse before the fall of potential becomes perfectly regular in the cable and bridge systems, owing to the time taken in the first instance for the cable to become charged along its entire length. This is even more so when the cable is coiled up in a tank owing to the induction between its turns. This may be clearly seen if the short circuit key be opened soon after applying the battery, by the deflection falling quickly at first, then gradually slower and slower, and ultimately to zero, supposing that a true balance has been obtained by the adjustable resistance. In the case of 1,000 miles, say, it is usual to open the short circuit key after about ½ minute battery application, and wait until the deflection ceases to fall, when it may be seen if any readjustment is necessary. The time required for each part of the circuit to take up its potential increases, of course, with the length, but in the instance given, five minutes is quite short enough for permitting a test of any accuracy to be effected. On page 232, Mr. Wilkinson practically admits as much, the above notwithstanding.

Again, on page 35 (in the main text), when speaking of insulation tests made aboard ship on picked up cable, the author says: "Each end in the testing room is then joined up in turn to the speaking-mirror connections, the station called up and asked to 'free one minute' or 30 seconds; and as soon as the reply comes 'O. K. done,' the end is instantly put over to the testing connections and the test taken." We question, however, the expediency of allowing such a short time for so important a matter. By the time "shore" had "freed" and "ship" had disconnected or switched over from speaking to testing apparatus, and perhaps hurriedly glanced over his connections, there would be very little time left in which to execute the test, even if one minute (much less 30 seconds) were sufficient period to assure that the cable was in a perfectly sound condition. It must be borne in mind that a steady electrification is the best guarantee that no incipient faults exist in a cable, rather than the number of degrees deflection given by the galvanometer needle during a more or less momentary application of electrical stress. For these reasons we should never join in any recommendation for an allowance much less than five minutes for "freeing" for this test, especially when we consider the many and various mishaps which may occur, and which are the more likely to under hurried conditions.

(To be continued.)

Les Tramways Electriques. By Henri Marechal. Paris: Baudry et Cie.

A few weeks ago we had occasion to publish (see the Electrical Review for January 1st, 1897), a critical notice of Messrs. Houston and Kennelly's book upon electric traction, and we now have before us a somewhat similar work by Mons. Maréchal, a French engineer of distinction in more branches than one. Although thus roughly summarised as a popular handbook to the study of electric traction, Mons. Maréchal's work is rather more than that, for it contains—intermingled with familiar common-places and descriptive accounts of too many old and useless methods or appliances—a great deal of quite new matter and information which will thoroughly repay the traction engineer for a perusal of the book.

As instances of this may be cited the three chapters dealing respectively with the overhead conductors; central stations or power houses; and the cost of operating; all these are treated in a most interesting way, embodying particulars not found elsewhere to our knowledge (except by perhaps rummaging through all the technical papers, both home and foreign). With the rest of the book we are somewhat dis-

appointed, not by reason of any possible want of completeness, or clarity of writing, in the descriptions and explanations given, but rather because the author has chosen to dilate so largely upon such matters as conduit systems—both open and closed; accumulators employed solely upon the cars, and old fashioned track like the Marsillon.

These are of course very interesting as matters of history, but they do not seem to us worthy of especial record and illustration in a book which might otherwise take high rank for its practical value, not only to outsiders but also to those actually engaged in electric tramway work.

Mons. Maréchal begins his work by a chapter on electric traction generally, and as a brief *resumé* of modern experience it could not readily be surpassed. Reprinted as a leaflet or tiny pamphlet this chapter alone would serve a very useful purpose, more particularly in the way of explaining to would-be electricians (directors of companies, town councillors, and the like), some of the theory involved, though not too much. Dealing next with the permanent way the author only describes three types of rail: the Broca (ordinary grooved girder); the American step rail, and the Marsillon compound rail. For European streets it is not likely that any other but the first-named, or its numerous prototypes, will come into use, so that the remaining two have only historical interest. The Marsillon rail gives very easy running, but is too expensive, both in first cost and maintenance.

Mons. Maréchal touches upon rail bonds, stray currents, and how to prevent them, working of grades, and average effort required (he takes 26 lbs. per ton as the coefficient of track resistance for ordinary tramway work). A 50 passenger car weighing, fully loaded, 10 tons (which seems rather too heavy) requires from 8 to 10 H.P. on the level, running at 6 to 8 miles an hour, and often from 6 to 7 times this amount when going uphill or at starting.

The next chapter discusses overhead systems, and as stated, is an excellent one throughout. Chapters iv. and v. deal entirely with conduit methods—open and closed. They are very fully illustrated, and contain all the necessary information obtainable as to the best of these systems; but since none of them is actually at work on an extensive scale, they do not come into serious consideration. The same remarks apply to the author's description of accumulator working. Full details are given, however, of the Paris battery cars, and a brief reference made to the Dresden and Hanover system of combined accumulator and trolley working. It is a pity that the author has not developed the theory of this method; it has some few germs of usefulness under certain conditions. After a chapter dealing with rolling stock and equipment therefor (in the electrical portions of which the author seems more particularly to shine, the descriptions of apparatus, &c., being extremely clear though brief; whilst the mechanical appliances are simply touched upon without any developments whatever), Mons. Maréchal discusses the central station or power house. For lines, he says, having only a few cars, say from 1 to 5, an average of 35 H.P. per car must be provided; for 5—10 cars, 30 H.P.; for 10—15 cars, 25 H.P.; 15—25 cars, 20 H.P.; and 25—30 cars, about 15 H.P. per car.

General matters relating to power house design are then gone into, and a useful description given with diagram of the booster battery arrangement at Fontainebleau, where the booster field is wound with opposing coils, so that it feeds the battery or trolley according to the load.

The remainder of the book is taken up with estimates of capital outlay, and working costs, &c., of the various electric traction systems, and the figures given appear to be tolerably accurate—some of them, moreover, sufficiently recent to have material value. As a rule, statistics of this kind are not extremely valuable, being far too rough and based on guesswork.

Taken as a whole, Mons. Maréchal's work is a very good and praiseworthy specimen of the "compressed handbook" order, and to judge from the instances where the author is original, he should be well able to give us a more elaborate treatise of high technical value contained in something more than the 200 pages into which he has somehow contrived to squeeze this guide to electric tramways. We congratulate him on having managed the task, but we do not envy him the labour of compression—the constant "holding back" for want of space. Next time he will doubtless "spread" himself, and we shall await the result with interest.

Handbook for Mechanical Engineers. By Henry Adams. Fourth edition. London: E. & F. N. Spon. 1897.

The author of this book has done a good deal of excellent practical work in technical literature, and this present book, though so very largely a compilation, is to be commended. The merit of a compilation is in the compiling thereof, and a good deal more genius may be expended upon a good compilation than upon an entirely original work. In the engineering world there is an enormous mass of crystallised practice and experience, and it is no easy task to choose from the mass those crystals whose facets will bear the light of modern knowledge.

The book is partly of the nature of a pocket-book, and partly a hand-book, and is full of very good and useful notes, rules and memoranda. It had slipped our memory, if ever we knew it, that the gallon measures 277·463 cubic inches, in place of the time-honoured 277¼, to which we had grown accustomed, or rather 277 274. But three other values of the gallon are given, and the engineer has got to pick which he thinks best. Some errors must surely creep into such a book as this, and surely it is an error to describe the pig-iron manufacture of the United States as only about 4,000,000 tons annually. Did it not one year exceed that of Great Britain? The table ought to be either dated or deleted. Similarly in the proportions of toothed gearing; no man who had any real experience would use ordinary gears with the old-fashioned length of tooth. Yet nothing is said to indicate that the rules given are long out of date.

Again, the rule for boiler seating blocks to be one-twentieth the boiler diameter in width is no good. It would seat an 8-foot boiler over a surface nearly 5 inches wide, whereas 3 inches is wide enough, and the latest blocks are made semi-circular in section at the line of contact, and are thus only in contact along a theoretical line.

These are blemishes, and doubtless there are many others. At the same time they are not fatal, and the book is one that can be honestly commended as a genuine effort to produce a collection of rules and other data that is, on the whole, fairly reliable, and even the points we have specially noted are only slightly out of date practice.

Tables Showing Loss of Head due to Friction of Water in Pipes. By Edmund B. Weston. New York: D. Van Nostrand & Co., 1896.

The author of this set of tables explains that he has made several hundred experiments, and endeavoured to secure reliable data on flow of water in pipes, and has finally constructed formulæ for his own use. These formulæ of his own are for smooth pipes like lead or brass, but for pipes about equal to new cast-iron, he concludes that two formulæ by the celebrated French engineer, Darcy, are reliable. For rough old pipes the author gives some multipliers to use with one of the tables to give approximate results.

The author is of opinion that the use of Darcy's formula may lead to rather high costs estimates, but at least their use would gain a man a repute for being safe, and he does not advise that close figuring down of sizes, which may end in undermining a reputation; a process to which employers are apt to compel a man who is at all weak.

It seems a pity that the author should give his results of discharge in U.S. gallons. It would have appealed to a larger *clientèle* to have given even in pounds, so as to be suitable for all the English speaking nations. There is room for the few extra figures. We have tried one or two results which seem to work out satisfactorily, and would say that the arrangement of the tables is very neat and clear. The tables are very full, results being given for equal intervals of gallons, or fractions of a gallon, per minute, the ½-inch pipe varying by 0·25 gallon, and the 3-inch pipe by 8 gallons per minute, while in the larger sizes as, say, 20 inches, only quantities of 50 gallons per minute are noted.

The tables include from pipes of half an inch up to 60 inches, so as to cover every grade of practical requirement. A few worked out examples are given to show the use of the tables.

For old pipes, only an approximation can, of course, be made, and the multipliers given are arranged on a basis of the number of years' service a pipe has seen, so that the results must be fairly liberally construed, for so very much depends upon the quality of a water as to the internal condition of a pipe.

CABLE MAKING AND WIRE COVERING MACHINERY.

On Monday last we were invited to the works of Messrs Johnson and Phillips, at Charlton, to see in operation several special machines, viz.:—a paper insulating machine, a four-headed vertical taping machine, and a steel tape sheathing machine in course of construction, and partly erected.

In addition, the following factory machines in daily use were inspected:—Large 12 bobbin cabling machine, longitudinal rubber covering machine, rubber lapping machine, double headed horizontal taping machine, India-rubber cutting machine, braiding machines, silk covering machines, cotton covering machines, vulcanising cures, fault testing, winding gears, &c., and, finally, a general inspection was made of works and of site for extensions.

Space will not permit us to allude in detail to the complete list, so we select the following as examples of Messrs. Johnson and Phillips's well-known manufactures, giving illustrations only of those appliances of a special nature:—

The Paper Taping or Insulating Machine is for insulating electric wires with paper instead of India-rubber. The machine is of abnormal length, and consists of a number of box framed standards which are mounted along wrought-iron girders. These girders carry eight heads, each one of which is fitted with three discs containing spools of paper, which would give 24 coverings, but as each strip of paper is arranged to half lap itself at each revolution, this gives 48 coverings at one operation. The discs are carried on quadrant studs, by which they can be set at any angle to suit the different sizes of cables and widths of paper. This was shown laying on tape in place of paper, and seems admirably adapted for its work, the mechanical details being well thought out and put together.

The Four Headed Vertical Taping Machine is a multiple machine for applying the coated tapings to the India-rubber covered leads previous to vulcanising. Each head is independent of the other for stopping and starting, and this is a great convenience in putting in new spools, &c. The machine can be operated by one lad, and its output is 40 miles per working day. It has separate drums for bare and covered wires of unusually large size, thus adapting the machine for very long lengths of cable. This attracted much attention, and in simplicity of design and ease in manipulation it is difficult to imagine any further improvement in this direction.

The Steel Tape Sheathing and Yarn and Compound Serving Machine is intended for applying the outer sheathing or protection for lead covered cables, consisting of two steel tapes, two or three servings of yarn, and three or four coatings of compound, but as we have already stated, this was not completed on the occasion of our visit.

Rubber and Cotton Covering Machine.—This is intended for covering wires with cotton and rubber. It is fitted with apparatus for straightening the wire, which is placed immediately in advance of the covering heads. The draw gear is variable to a very fine degree by means of special cone gearing. It is arranged to work either with cotton wound on its own bobbins, or from the spools just as they are supplied from the cotton mills. The manufacturers have supplied quite a number of these machines from time to time, more particularly to firms on the continent, where this class of covered wire is largely used.

Vertical Multiple Stranding Machine.—This is specially adapted for making steel wire strands, but it is also suitable for electric cables. It has two heads, each fitted with 12 bobbins, and capable of forming 19 wire strands, and the heads can be started and stopped independently of each other. The bobbins are fitted with eccentrics to obviate the twisting of the wire. The machine has automatic "take up" gear, also "traverse" gear, for flaking the finished strands on to the drums. It was made for the order of a German firm.

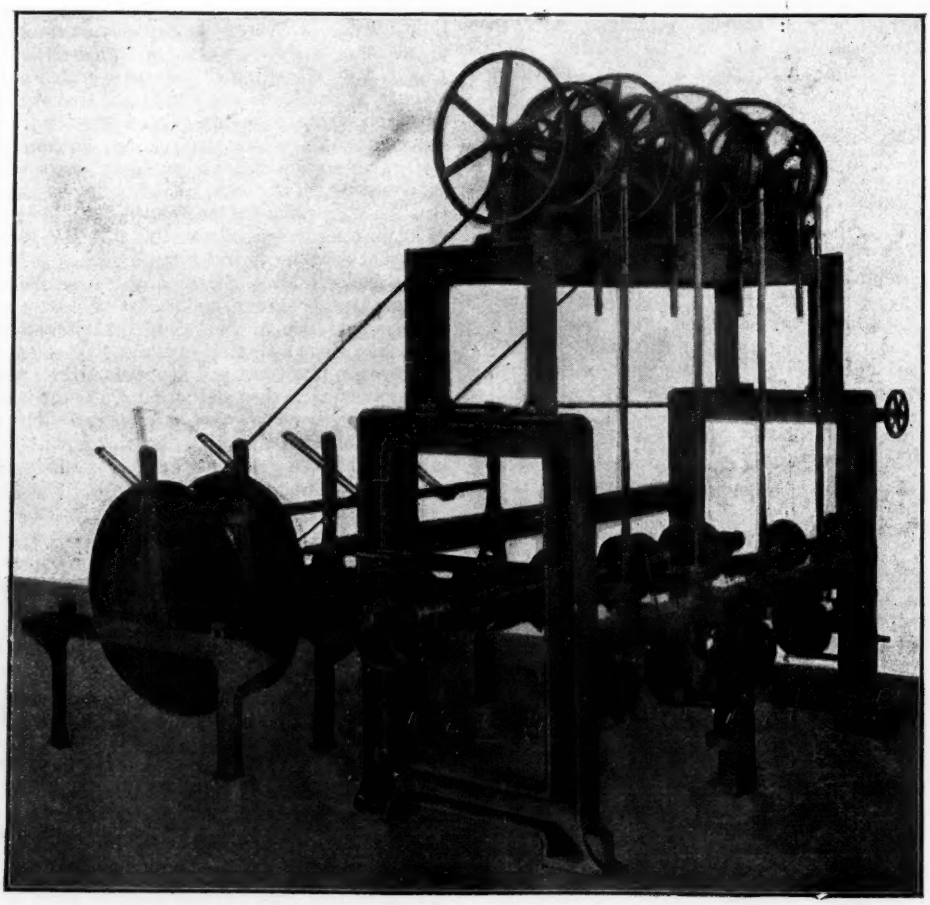
Double Taping Machine.—This machine is designed for covering electric light and other cables with the various kinds of insulating tapes which go to make up the "dielectric" adopted in different countries. The particular machine shown has been made in duplicate for Germany. It is adapted for the following coverings:—

1. Pure rubber.
2. Compound rubber.
3. Plain canvas tape.
4. Compounded canvas tape.
5. Parchment tape.

&c. &c.

The machine is complete with change wheels to give the various lays.

Combined Sheathing and Serving Machine.—This is one of the many machines turned out by the firm for sheathing submarine cables with iron and steel wires, and serving the various protective coatings with yarn and compound in one operation. This machine is applicable for deep sea, intermediate, and shore end cables. It was made for one of the great cable companies for use in one of their foreign factories. Similar machines have been made for France, Germany, Italy, &c. It is fitted with all recent improvements, including adjustable anti-friction rollers, to middle disc and "lay head" for easy running and taking up wear. The brake arrange-



Four-Headed Vertical Taping Machine.

ments are special, and of flat steel straps, which is found to be more durable, and gives a more even tension than rope.

Double Rubber Lapping Machine.—This is another example of a highly efficient machine, being the outcome of the firm's own extensive use of the machine. It is for covering wire with two coatings of pure rubber, and is arranged for a speed of 1,200 (twelve hundred) revolutions, thus giving it the very large output of five miles per day. The draw gear is variable by means of change wheels.

Messrs. Johnson & Phillips, who occupy a leading position in this branch of the electrical industry, are probably the largest manufacturers of this class of machinery in the kingdom, and some idea of the scope of their operations may be gathered when we say that amongst the descriptive matter tendered to the visitors were illustrations of between 60 and 70 different machines. The Charlton firm are not only makers, but users of this special machinery, so intending purchasers can inspect most of the apparatus in operation at the works, which is a decided advantage. The Continent is largely supplied by Messrs. Johnson & Phillips, and orders have even been received from Japan.

CORRESPONDENCE.

Closed Arc Lamps.

In view of what has already been conclusively proved concerning the Jandus lamp, we are surprised that you should publish such statements as are contained in your last issue without any reference to the fact that they are opposed to the experience of others.

In common fairness we would ask you to give the same publicity to the reports of Professors Houston and Kennelly, which we send herewith, so that your readers may form a just conclusion.

We may add that these professors were quite as disinterested as M. Pierron, and their results are found to accord with practice, which is not the case with M. Pierron's.

Fortunately, in this instance it is easy to diagnose the cause of the erroneous results. Your correspondent has given us the clue in his analysis. He has placed his carbons so as to burn the iron cap at the top of the inner globe, which at once clouds the glass in the way he describes. Any tests after this has happened are, of course, without value.

We must again remind you that if there is any powdery deposit on the inside globe the lamp is not burning right as regards voltage, carbons, and length of arc. We get a slight discoloration at the extreme top of the globe produced in first starting up, owing, we presume, to the oxygen in inner globe, but at the end of the 180 or 200 hours' burning the rest of the glass is clear.

After so many Jandus lamps have been tested in yards and streets against the old fashioned lamps, and the Jandus has invariably been declared to give more light, surely there is no need for your paper to try and scare intending purchasers needlessly. We should be sorry to think that your action in collecting these hostile foreign clippings was other than disinterested, but it would appear to be open to this interpretation.

Drake & Gorham.

[The very aggressive attitude which has of late characterised the communications of Messrs. Drake & Gorham, whenever comparisons between open and closed arc lamps have resulted unfavourably to the particular system they control, cannot fail to have been noticed by our readers.

The figures obtained by Houston & Kennelly with the Jandus arc lamp were published in our issue of February 28th, 1896, page 281.

It will be interesting to compare the data given by these gentlemen and that of M. Pierron, to which Messrs. Drake and Gorham so decidedly object :—

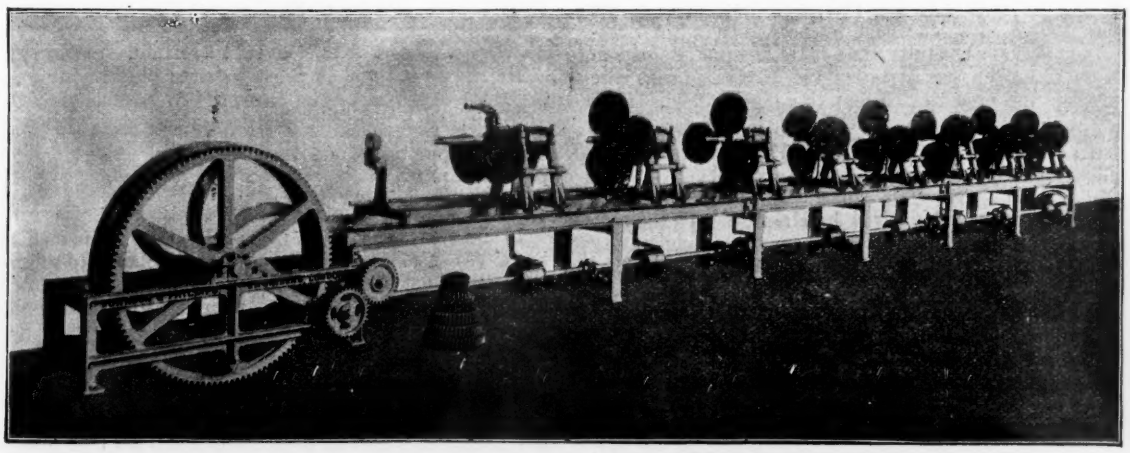
	Watts used.	Mean luminous intensity.
H. and K.	... 616	... 667 British standard candles.
Pierron	... 607 to 640	... 701 German standard „ or 876 British „ „ reduced from the German.

Thus M. Pierron, with about the same average consumption of electrical energy as was used up in the Houston and Kennelly tests, gets a better result for the mean luminous intensity of some 200 candles! Can this be called a test without value to the proprietors of the Jandus lamp, and why should not the readings from the Siemens lamp be equally reliable?

Pierron, furthermore, did not employ a clear glass for his inner globe, therefore the showing seems still more favourable for the Jandus. The real points of doubt appear to lie in the want of agreement between Houston and Kennelly's borrowed figures for the naked arc, and M. Pierron's actual measurements.

Moreover, if M. Pierron has fallen into error, so have we. Messrs. Drake & Gorham were good enough to lend us a Jandus lamp, which was tried under various conditions both for inside and outside work. It was noticed that a film formed on the inner globe of a more or less opaque nature, which could be scraped off with a knife, and comes away in a similar manner to a photographic film. This certainly reduced the illuminating power as the carbons were gradually consumed.

The mere declaration that yards or streets appear to be better lighted with the Jandus than with old-fashioned lamps is hardly scientific. In the circular with which the report of Houston and Kennelly is embodied, Messrs. Drake and Gorham specifically state that "No just comparison could be made with other lamps without a knowledge of the energy expended in the arc of the lamps compared;" but Houston and Kennelly do not give us this very desirable information when estimating the performance of the Jandus against "an average of 26 short arc lamps by different makers," but M. Pierron does place us in possession of the necessary data in his comparisons. M. Hospitalier, whose article we translated, will doubtless feel flattered to see it spoken of as a "hostile foreign clipping;" and, as to the interpretation put upon our conduct of this journal, we are fain to believe that our correspondent's firm is the only one which would credit us with other than absolutely disinterested motives.—Eds. Elec. Rev.]



Cable Making Machinery.—Paper Insulating Machine.

Indian Patents.

At the instance of the Society of Patent Agents, the Government of India have agreed to issue a patent document of an imposing form, placing on record the fact that an applicant for an Indian patent has duly complied with all preliminary requirements, and certifying that the Governor-General in Council authorises the filing of a specification of an invention. This is in lieu of a former meagre announcement of leave being given to file a specification in the *Gazette of India*, or an insignificant looking certificate, which was all that the agent had to hand to his client.

Reginald W. Barker,
p. H.C.,
Hon. Sec. Society of Patent Agents.

March 3rd, 1897.

Theory of Constant Speed Direct Current Motors.

I notice in your current number an article on compound-winding of motors by Mr. Rhodes which I think is likely to prove somewhat misleading to those not practically conversant with motor design.

Passing over some obvious clerical errors, I would point out that it is assumed that the reluctance of the magnetic circuit is a constant, a thing which is not the case, seeing that the whole adjustment is brought about by an alteration of the density in the iron parts of the machine. This assumption leads Mr. Rhodes to a relationship between the numbers of convolutions and the resistances of the coils which does not occur in practice; for, whilst the various resistances may be fixed beforehand, and depend simply upon the efficiency desired, the number of convolutions of the series coil depends upon the part of the β H curve being used.

I would point out that in stating the armature reactions to be such as to strengthen the field, a forward lead of the brushes is assumed which would be inconsistent with sparkless commutation; and also that in estimating the ampere turns so acting on the armature the current in each wire is only half the armature current in a bipolar field. Thus the armature ampere turns are $\frac{\lambda\, i\, C}{360}$, and not $\frac{\lambda\, i\, C}{180}$ as given by equation (13), p. 271.

How wide his results are from actual practice may be gleaned from the example given by Mr. Rhodes on the next page, where it would appear that a motor designed for 10 kw. "might therefore be used for a normal load of about 2 kw."

I need hardly say that when I design a motor I make the maximum efficiency coincide with full load, and certainly not with only one-fifth load. Moreover, an electrical efficiency of only 90·5 per cent. at one-fifth load falling to less than 75 per cent. at full load is not quite up to date for a 10 kw. machine.

As the question of motor compounding is of some interest, I enclose a paper giving the formulæ used by myself when designing motors.

S. Joyce.

I.—Long Shunt.

Let C_o = friction load armature current.
e_o = „ „ back E.M.F.
N_o = „ „ armature flux.
F = „ „ in watts.
n = revolutions per second.
w = wires all round armature.

then

$$C_a\, e_o = \text{F and } e_o = \frac{N_o\, n\, w}{10^8}$$

whence

$$\frac{C_o\, N_o\, n\, w}{10^8} = \text{F and } n = \frac{\text{F} \times 10^8}{C_o\, N_o\, w} \qquad (1)$$

Also, if W = output in watts.
C_a = full load armature current,
e_a = „ „ back E M.F.,

then

$$C_a\, e_a = \text{W} + \text{F and } e_a = \frac{N_a\, n\, w}{10^8}$$

whence

$$\frac{C_a\, N_a\, n\, w}{10^8} = \text{W} + \text{F or } n = \frac{(\text{W} + \text{F})\, 10^8}{C_a\, N_a\, w} \qquad (2)$$

Now when n is to be constant (1) = (2) or

$$\frac{C_o\, N_o}{C_a\, N_a} = \frac{\text{F}}{\text{W} + \text{F}} \qquad (3)$$

If now E be the P.D. of supply, then

$$C_o = \frac{\text{E} - \frac{N_o\, n\, w}{10^8}}{R_a + R_m} \text{ and } C_a = \frac{\text{E} - \frac{N_a\, n\, w}{10^8}}{R_a + R_m},$$

putting which values in (3) we have

$$\frac{\text{E}\, N_o - \frac{N_o^2\, n\, w}{10^8}}{\text{E}\, N_a - \frac{N_a^2\, n\, w}{10^8}} = \frac{\text{F}}{\text{W} + \text{F}}. \qquad (4)$$

whence

$$N_a = \frac{\text{F E} + \sqrt{\left\{\text{F}^2\text{E}^2 - \left[\left(\frac{4\,\text{F}\, n\, w}{10^8}\right)\left(\text{W} + \text{F}\right)\left(\text{E}\, N_o - \frac{N_o^2\, n\, w}{10^8}\right)\right]\right\}}}{\frac{2\,\text{F}\, n\, w}{10^8}} \qquad (5)$$

and $N_a < N_o$.

Now, at no load, we may take the excitation to be due simply to the shunt, since the value of C_o is so small as not to affect the question either by the series coil or by armature reactions, whence

$$\frac{\text{E}\, T_s}{R_s} = 0{\cdot}8\, N_o\, K_o \qquad (6)$$

when T_s and R_s are respectively the convolutions and resistance of the shunt coil, and K_o is the reluctance of the magnetic circuit for a flux of N_o lines.

But when loaded the armature winding weakens the field when the brushes are given the usual backward lead for sparkless commutation, and then, neglecting the effect of the series coil, the magneto-motive force is now

$$\frac{\text{E}\, T_s}{R_s} - \frac{2\,\lambda\, w\, C_a}{360 \times 2} = \frac{\text{E}\, T_s}{R_s} - \frac{\lambda\, w\, C_a}{360} \qquad (7)$$

where λ is the angle of lead.

But now the reluctance of the circuit is less than before, since the iron parts, are less densely magnetised, and the M.M.F. required is

$$0{\cdot}8\, N_a\, K_a. \qquad (8)$$

If now this is equal to (7) we shall need no series winding; but if (8) < (7), then we require series winding to subtract from the shunt the value of the difference. Or, as is sometimes the case, when (8) > (7), then the series winding may have to add to the effect of the shunt.

So far, however, we have assumed that the current in the armature is the only reacting force; but since for a given polarity and method of winding with the current in the armature, in the same sense we have the motor running in the reverse direction to a dynamo, it follows that whereas eddy currents in a dynamo increase the armature reactions in a motor they tend to decrease them. This will cause the necessary series winding to be slightly more negative or less positive than would otherwise be the case.

It is sometimes assumed that the motion of the armature actually drags the field round with it, giving it a twist in the same sense as that produced by the armature reactions in a dynamo. This effect, if any, will of course still further reduce the deformation of the field in a motor; but since it is well known that a motor has still a considerable magnetic twist, it seems likely that this mechanical twist must be very small if not absent altogether.

We have also assumed that the value of the no load friction is constant; but this will not be strictly the case. This friction load is made up of hysteresis, eddy currents, and mechanical friction. Of these the first will be slightly less at full load, since N_a will be less than N_o; for the same reason also the eddy current loss will also be less; but the mechanical friction may be greater, depending upon the nature of the gearing employed. In any case it is only the efficiency of conversion which is affected and not the compounding.

II.—Short Shunt.

In this case, whilst the current flowing in the series coil is now the main current supplied, the P.D. at the shunt terminals will be variable, decreasing as the load increases due to the drop in series coil.

Using the same symbols, we now have

$$C_o = \frac{E - \frac{N_o n w}{10^8}\left(\frac{R_m}{R_s}+1\right)}{R_a + R_m + \frac{R_a R_m}{R_s}} \text{ and } C_a = \frac{E - \frac{N_a n w}{10^8}\left(\frac{R_m}{R_s}+1\right)}{R_a + R_m + \frac{R_a R_m}{R_s}}$$

Putting which values in (3) and solving, we get

$$N_a = \frac{FE + \sqrt{\left\{F^2E^2 - \left(\frac{4 F n w}{10^8}\right)\left(\frac{R_m}{R_s}+1\right)(F+W)\left(E E_o - \frac{N_o^2 n w}{10^8}\left(\frac{R_m}{R_s}+1\right)\right)\right\}}}{\frac{2 F n w}{10^8}\left(\frac{R_m}{R_s}+1\right)} \quad (9)$$

N_a being again less than N_o.

At no load the excitation is again practically that of the shunt, or

$$\frac{E T_s}{R_s} = 0\,8\, N_o K_o. \quad (10)$$

But when loaded the P.D. at the shunt terminals is reduced by the drop in R_m, and then is also the demagnetising effect of the armature; or, again, for the moment neglecting the effect of the series coil, the magneto-motive force is now

$$\frac{(E - C R_m) T_s}{R_s} - \frac{\lambda w C_a}{360}. \quad (11)$$

The reluctance of the circuit is again less, the actual magneto-motive force being

$$0{\cdot}8\, N_a K_a \quad (12)$$

The number of series turns required, and their direction of magnetisation as before depending upon the equality or otherwise of (11) and (12)

As in a dynamo, the short shunt leaves less for the series coil to do, since the shunt coil is affected in each case by a P.D. varying with the load.

In both cases we can fix N_o and the resistances of the coils before designing the motor: the shunt winding at no load is thus easily found. The necessary series turns are then added and will depend simply upon the condition of the magnetic circuit being quite independent of the resistances of any of the coils. It must be remembered that in the long shunt the series coil current is C_a, but is C in the short shunt.—S. Joyce.

In the above article we find the statement that, "it is known that the field of a direct current motor is strengthened by armature reaction," and Mr. Rhodes goes on to say that extra series winding must be put on to counteract this. But since the direction of the current in the armature conductors is in the opposite direction to what it would be in a dynamo, and the lead to the brushes is also in the opposite direction, backwards instead of forwards, the effect is to weaken the field just as in a dynamo; and therefore the amount of series wire calculated, without considering armature reactions, must be *reduced* by an amount equivalent to the opposing armature field.

Further, the current divides in the two halves of the armature, and each conductor carries only half the current carried by the series winding, therefore the expression $\frac{2\lambda}{360} C$ should be $\frac{\lambda}{360} C$, when C is the number of conductors on the surface of the armature, and λ the angle of lead.

The expression for series winding, neglecting the armature reactions, is only approximately accurate, since the reluctance of the magnetic circuit must be supposed constant at all loads, which, of course, it will not be.

A Student of the Manchester Technical School.

March 1st, 1897.

Thanks to the courtesy of the editors of the Electrical Review in forwarding to me advance proofs of the letters of Mr. Joyce, of the Manchester Technical School, and his pupil, I am enabled to reply without delay to their criticisms of my article which appeared a fortnight ago.

I regret having made the obvious mistake in the correction for armature reaction, and my thanks are due to them for drawing my attention to the error. As they state, the field is *weakened* by armature reaction, and equation (13) of my article should read

$$S = -\left(\frac{r + r_1}{r^1} S^1 - \frac{\lambda}{360} C\right).$$

I wish Mr. Joyce had taken the trouble to note explicitly the "obvious clerical errors" which, he says, he passes over. I must confess that I fail to detect them.

My critic condemns my article because the calculations are based on the assumption of constant magnetic reluctance.

No one who understands the simple rules of algebra can quarrel with the calculations up to equation (11), which is

$$n = \frac{10^9 R i^1}{2 \pi C S^1}.$$

If we differentiate this we get

$$\frac{d n}{n} = \frac{d R}{R},$$

which shows that any change in the reluctance, R, is accompanied by an equal percentage variation of the speed, *n*.

The possible percentage variations of R are determined by the induction at which the motor is worked, and by the ratio of the reluctance of the iron circuit to that of the whole magnetic circuit, including the air gap. It appears to me, therefore, that changes in the reluctance will not be so great as to render either useless or uninteresting calculations based on the assumption that it is constant.

Any criticism on this point which does not show the exact percentage variation of the total reluctance from no-load to full-load is worthless.

Evidently Mr. Joyce has not understood the latter part of my article or he would not so freely ridicule my figures. He seems to think that the terms "maximum output" and "full-load output" are synonymous. I did not consider it to be necessary to explicitly define them in an isolated article. It may, however, help him to understand the terms if I repeat that the full-load output of the motor in question is 2 kilowatts when the electrical efficiency is a maximum, whereas the load may reach 10 kilowatts (maximum output) before pulling up the motor—a result which might occur in a motor "in actual practice."

W. G. Rhodes.

Salford, *March 9th*, 1897.

The "Rapid" Cable.

At the end of the article, under above heading, by Mr. J. Rymer-Jones, page 309 of your issue of to-day, he says:

"It seems therefore remarkable that no one should have discovered earlier the extraordinary power which distributed leaks possess in accelerating speed, if Prof. Thompson's expectations are to be realised."

The effect of leaks on speed of working has long been known. I have in my hand at this moment a letter written to me on March 10th, 1887, by Mr. Oliver Heaviside, on this very subject. After discussing other methods he says:

"But a really good and sound way (in default of using bigger conductors) is by leaks. They greatly facilitate the charging and discharging, and in consequence quicken the current variations at the distant end. You can *double* the speed by proper leaks, and still have enough current arriving to work by. There are two ways I have proposed—artificial leaks, and insulation of comparatively low resistance, say 1 megohm per mile instead of hundreds. I have no doubt that either one or the other will be done some day."

In addition to the quotation you will find that in the articles contributed to a contemporary by Mr. Heaviside, in 1885 I think, he gives an example which came under his own observation of increased speed and better definition produced by accidental leaks.

David Cook.

March 5th, 1897.

Assistant.—If you will send us your name and address, we will insert your letter and reply to your query?

E

Long Burning Arc Lamps.

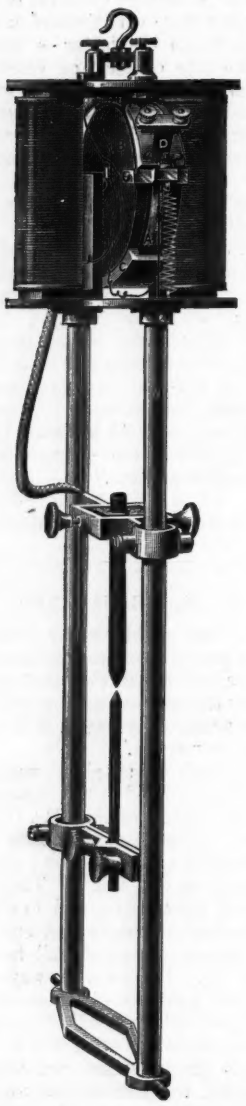
Referring to the communications in your last issue, signed by Mr. J. B. Barlow and Messrs. Drake & Gorham, I deem it inexpedient to be drawn into a discussion which might have a material effect on any proceedings that may hereafter be fought out in Court. That is the proper arena for a matter of this character, and I am content to wait till then to give your correspondents all the information they may require.

L. B. Marks, M.M.E.,
Chief Electrician, The Electric Arc Light Company, U.S.A.

Savoy Hotel, *March 10th*, 1897.

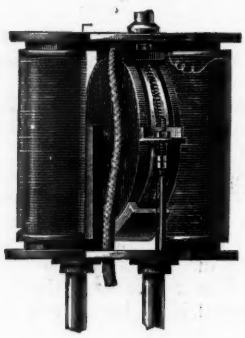
THE BLAHNIK ARC LAMP.

There is probably no branch of electrical mechanism that has claimed more attention during the past few years than that of the arc lamp. It has been the laudable aim of inventors to produce a lamp which burned with absolute steadiness, and whose mechanism was of the simplest



character. There have been lamps that have been fairly regular in their habits, but though these merits were undoubted, there has been a lamentable lack of simplicity. On the other hand, many lamps have been made which were perfectly simple in design, but woefully unsatisfactory in performance. Of the hundreds of arc lamps that have been invented and patented, probably the number of those that are really reliable in their action does not exceed a round dozen.

The very latest arc lamp that has been put on the English market is the Blahnik, and the claims of the promoters are sufficiently startling to warrant some considerable attention being paid to it. The lamp is the invention of an Austrian engineer, M. Antoine Blahnik, and has been developed to a considerable extent in France by a French company. It is apparently well known among French engineers, and has been highly spoken of by the Continental technical Press. By the kindness of the English proprietors, who rejoice in the title of the British Blahnik Arc Light Company, we have recently had an opportunity of inspecting the working of this lamp under various conditions, and as far as we could judge from a perfunctory examination, it is apparent that some of the claims put forward are not exaggerated. It will be seen from an examination of the drawings that the mechanism of the lamp is of the most simple description. The operation of the lamp may be said to depend upon the attraction by shunt coils of two discs of charcoal iron, to which is attached a brake piece, revolving on an eccentric. Between the two discs is a pulley which permits the movement of the carbon holders. To describe the action in greater detail, it will be necessary to refer to the accompanying illustrations. It may be said that when a current first passes into the shunt coils—and we will assume for the moment that the carbons are wide apart—the two iron discs



shown at B are attracted by and towards the armature of the electro-magnet, and this operation has the effect of releasing pulley, A, which permits the carbons to come together, the upper carbon falling by its own weight, and through the action of the pulley bringing up the lower one. As soon as the carbons touch, however, the current following the path of least resistance is immediately diverted through the carbons, and the electro-magnet becoming partially demagnetised, the soft iron discs fall back into their previous position, but in falling back they reverse the pulley to a slight extent, which has the effect of separating the carbons sufficiently to strike the arc.

The operation of the pulley is completely controlled by the brake, which is shown at D. The brake, under normal conditions, controls the pulley by pressure, but this pressure becomes relaxed when the soft iron discs are attracted to the armature; by means of two screws the pressure of the brake on the pulley may be increased or decreased as desired. The amount of movement of the soft iron discs may, to some extent, be regulated on one side by a wire spring, and on the other side by a screw. The two soft iron discs, it may be mentioned, are held by a brass piece, shown at C. One side of each carbon-holder slides in a leg of the framework, insulation being obtained by means of glass beads or other suitable means. It will be seen from these few remarks that the operation of the lamp is simple in the extreme, and moreover, the feed is continuous and easy in its character.

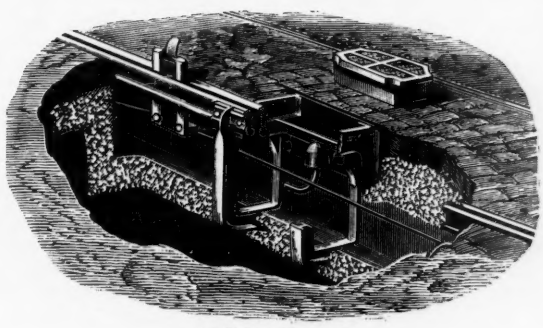
As we have mentioned before, we have watched the performance of the lamp under various conditions, on public mains and on private supply, and the arc was marked by great steadiness, nor did a violent shaking or knocking interfere in the slightest degree with the regularity of the light. It is obvious that with so little mechanism the lamp is an exceedingly light one—we mean, of course, avoirdupois—indeed, the one from which the illustrations were made does not weigh more than 10 lbs., and with the use of aluminium

for various parts they have been made as light as 7 lbs. A peculiar feature was the readiness with which the lamp adjusted itself to various degrees of current; for instance, the normal current of 8 amperes can be increased to 20, and even 30 amperes, with no material effect on the lamp, the increase of current being followed by a longer and, consequently, more powerful arc. They are designed to run two in series, but Mr. Keys, the managing director of the Blahnik Arc Light Company, informs us that the voltage of the lamp is not more than 35 volts, therefore there is no difficulty in putting three in series across 110 volt mains. This, we need hardly say, is a remarkable attribute, which, if practicable, ought to be of great importance, but possibly he was referring to alternating circuits only. Considerable experience has been obtained of the behaviour of the lamp under ordinary working conditions, and as regards laboratory tests, M. Henri Besson, who tested two lamps, says: "We can vouch that M. Blahnik's lamp is most simple, which in itself is a guarantee of good working. It is made on an absolutely rational principle not yet employed in arc lamps—that is to say, the attraction of an eccentric by an electromagnet. Beyond that the result of its simplicity is that its cost price would certainly be lower than that of the present lamps. Such a lamp will work equally well with a continuous or alternating current; for that purpose it will only be necessary to laminate the iron of the magnetic circuit." Without seeking to depreciate the results of M. Besson's tests in the slightest degree, it goes without saying that engineers will be more inclined to ask for results of practical working, and they could have nothing better than the fact that the complete lighting of the Cycle Exhibition held at the Palais de l'Industrie, Paris, last December, was done by Blahnik lamps, 450 of them being in use. The cost of production of these lamps is exceedingly low, and the Blahnik Company will put them on the market at what will be considered distinctly low prices. It is scarcely necessary to add that the simplicity of the mechanism and the steadiness of the arc are the most noticeable features in an altogether admirable lamp.

THE "SIMPLEX" SYSTEM OF ELECTRIC TRACTION.

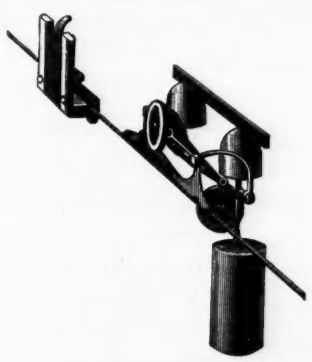
On Tuesday last a demonstration was given at the works of the British Insulated Wire Company, at Prescot, of the Simplex System of Electric Traction. It may be said at the outset that the system is a conduit one, but the chief feature is the employment of a flexible conductor, which is supported underground at intervals, somewhat after the manner of an overhead conductor. From the observations that we made during the demonstration, the system worked exceedingly well, and appeared to us to be one of the simplest conduits that has been devised, and is markedly free from the mechanical weaknesses which usually characterise underground systems. Within certain limits it ought to prove to be of considerable utility, and in cases where overhead systems are absolutely precluded, there is reasonable hope of the Simplex system fulfilling all requirements.

The conduit differs from most others in being, comparatively speaking, narrow; it is, under average conditions, about 12 inches deep, and some 7 or 8 inches wide. It is built of concrete, in which are embedded the yokes or chains supporting the rails, and is under one of the running rails, the top of the conduit, through which access is obtained to the conductor, being made by two rails, one of which forms the tread of the rail. The slot thus formed is about 1 inch wide at the top, though one of the rails being provided with a lip, after the style of a modified girder rail, reduces the width to about $\frac{5}{8}$ths of an inch. A fair idea of the arrangement of conduit and conductor will be obtained from the illustrations. As we have already observed, the essential feature of the system is the use of a flexible conductor which rests on insulators, placed on an average straight track about 30 feet apart. Needless to say, the frequency of these insulators depends a good deal on the particular conditions that prevail. The insulators are placed in a special form of box, one of which is illustrated, the box being made up of two of the yoke irons, which serves to support the double rail. The great point about these insulators is, that it is possible to examine every one by simply removing the lid of the box. Another point of utility about the boxes is that they permit the drawing out and threading in of a conductor, if the necessity of such a course arises, without in any way interfering with the conduit. The conductor simply rests upon the insulators, but at every quarter of a mile there is a special box which contains straining gear, the particular function of this being to compensate for any lengthening of the conductor, thereby preventing it from touching the bottom of the conduit. The straining device is one of the most interesting features of the system, and may be briefly said to consist of a sleeve, which securely grips the conductor. The sleeve is carried by two arms which, while being efficiently insulated, have attached to them a weight, operating over a pulley; obviously the weight



An Insulator-box.

keeps the conducting wire taut, and takes up any slack that might arise from, say, an expansion of the wire. In addition to a straining device at every quarter mile on a straight track, one is placed at the commencement and end of every junction, turn out or points, or they may be more frequent at curves. The straining apparatus placed at points differs materially from that contained in a straight track box, the difference arising from the fact that the working conductor becomes discontinuous. For instance, at the commencement of a turn out or point, there would be a box in which the wire would be attached to one end of the straining device, but the other side of the straining device would be connected to an insulated cable, which is carried in an earthenware pipe to the next box; in other words, the continuity of the system is maintained at junctions by means of insulated cables. As, however, the distance between two boxes where



Straining Device.

the working conductor becomes merged into an insulated cable, is less than the length of the car, the foremost collector will have reached the beginning of the bare conductor in front, before the rear collector leaves the last box. In other words, the two collectors bridge the intervening space between the bare conductors. It will be gathered from what has been said that two collectors are provided on each car. There is no very special feature about the collector, except for the fact that the conductor, being flexible, permits of it being rigid. One of the illustrations shows the exact position of the collector with regard

to the conductor. As the car passes along, the U-shaped collector simply lifts the conductor, and when the car has passed, the wire simply drops back again on to its support, or arms; at points, however, where the straining boxes at curves are provided, or where the special supports are provided, the collector simply lifts the whole of the device, the constant pull of the weight aiding the operation. The percentage of the whole weight which deflects the support can be adjusted, as the cable can be made to pass as nearly through the axis of rotation of the tension apparatus as desired. The collector now employed differs slightly from what is shown in the illustration; a flat piece of metal, one end of which is rigidly attached to a special frame under the car, carries, at the end which operates in the conduit, a gun-metal shoe about 12 inches in length, which serves as the collector. The shoe is slightly curved downwards at each end, so that the wear comes, practically, on the middle. It is insulated from the flat metal piece by slate, porcelain, or some suitable material, the live portion being attached to an insulated wire carried through a hollow space formed in the shank of the collector and thence to the controlling device on the car.

The experimental track on which the demonstration was made was about a quarter of a mile in length, and, besides having a somewhat heavy gradient, was furnished with a curve of short radius, as well as some difficult points. The running of the car was, however, perfect, the points, curves, and gradients being taken with the greatest ease. Stones hammered into the slot were pushed out by the collector with so little trouble, that one might surmise that there could be few obstructions put on the line which would interfere with the working of the collector. The car was of the ordinary type, built by Messrs. Milnes, of Birkenhead. It was provided with two motors of the General Electric (America) type, and was furnished with a K controller at each end. The generating plant, which was placed in an iron building near the track, consisted of General Electric direct-coupled motor generator, current for the motor being supplied from the adjoining works of the British Insulated Wire Company. The pressure of the current was 500 volts.

There is little doubt that the demonstration proved the workability of the system, and a minute inspection showed that the various details had been worked out with much care and a great deal of ingenuity.

We are informed that the average cost of constructing a tramway on this system of a standard 4 feet 8½ inches gauge, inclusive of all work, with 5-inch granite paving on a 6-inch bed of concrete, is estimated at £6,000 per mile of single line of track. This also includes the electrical equipment in the conduit, but is exclusive of the feeders, which, of course, vary in each particular case, but includes a separate pipe conduit into which the feeders can be drawn. In view of the fact that an ordinary horse tramway, under similar conditions, costs about £4,000 per mile, the Simplex system has much to recommend it.

BUSINESS NOTICES, &c.

Bankruptcy Proceedings.—The first meeting and public examination are to be held on March 12th and April 1st respectively at 11 a.m. at Bankruptcy Buildings, Carey Street, W.C., in *re* Wm. Alan Fraser, electrical engineer, carrying on business at 18, Cecil Court, Charing Cross Road, W.C.

Book Received.—*L'Eclairage à l'Acétylene*, par G. Pellissier. Published by Georges Carré et C. Naud, Paris. Price 5 francs.

Change of Address.—The offices of the *Engineering Magazine* have been removed to 120-122 Liberty Street, New York, in the heart of the machinery district.

Dissolutions of Partnerships.—Messrs. Wm. Peto and F. W. A. Radford, carrying on business as electrical engineers and contractors at 57B, Hatton Garden, London, under the style of Peto and Radford, have, according to the *London Gazette*, dissolved partnership by mutual consent as from January 1st. We announced last week that the firm had been formed into a limited liability company, *i.e.*, Peto & Radford, Limited.

In our notice of the registration of the new company, the registered address is given as 57B, Clerkenwell Road. The address should be 57B, Hatton Garden.

Electrical Wares Exported.

Week Ending Mar. 9th, 1896.	£	s.
Adelaide	60	0
Alexandria	128	0
" Teleph. mat.	25	0
Algoa Bay	72	0
Amsterdam	150	0
Bordeaux	121	0
Brisbane	125	0
" Teleph. mat.	648	0
Calcutta. "	20	0
Cape Town	694	0
Copenhagen. Teleg. wire	276	0
Melbourne	262	0
" Teleg. mat.	240	0
Rotterdam	801	0
Sydney	299	0
Wellington	37	0
Total	£3,958	0

Week Ending Mar. 9th, 1897.	£	s.
Albany	131	0
Alexandria	25	0
Amsterdam	20	0
Bilbao	12	0
Boca. Teleg. mat. ...	72	0
Bombay	132	0
Brussels	18	0
Buenos Ayres	724	0
Calcutta	49	0
Cape Town	415	0
" Teleg. mat.	1,400	0
Colombo. Teleg. mat. ...	79	0
Danzig	19	0
Durban	1,139	0
East London	336	0
Flushing	27	0
Fremantle. Teleg. mat.	27	0
Havana	12	0
Port Elizabeth	146	0
Singapore. Teleph. mat.	10	0
" Teleg. cable 2,598 tons.		
Sydney	242	0
Teneriffe	10	0
Valencia...	18	0
Venice	6	0
Yokohama	15	0
Total	£5,084	0

Foreign Goods Transhipped.

	£	s.
Gothenburg. Telephone	11	0
Total	£11	0

Ediswan Company.—We understand that the Edison and Swan United Company are so busy at their Ponder's End works, that new premises are being erected to enable them to cope with orders. Among contracts recently secured are the supply of boxes, lampholders and lamps for the Blackwell Tunnel for the London County Council, and electrical apparatus for the Islington Vestry, the Northern Polytechnic, &c. There is a great demand for high voltage lamps.

Electrical Sundries Company.—This company, whose offices are at 10, Berners Street, London, W., inform us that they are carrying on a business, under their manager, for the sale of electric light fittings and accessories, similar to that carried on by him, until December 31st last, as managing partner of the London depôt of Messrs. Wm. McGeoch & Co. The company retains the same staff as formerly engaged at Berners Street. We have received a copy of their new illustrated catalogue, describing and illustrating their manufactures, for which reduced prices are noted. The list is devoted to switches, cut-outs, fuses, plugs, lamp holders, standards, pendants, and similar electrical fittings and accessories.

Francis & Spilsbury.—We understand that Messrs. Heaton, Smith & Co., of Salford Switch Works, Manchester, have appointed as their sole London and South Country agents Messrs. Francis & Spilsbury, of 20, Bucklersbury, London, E.C., to whom all inquiries and orders should be addressed. Stocks of Messrs. Heaton, Smith & Co.'s well-known "H. S." type main switches, their new "Triumph" quick break double-pole main switches, "Thumb" pattern switches, ship fittings, &c, will be kept in London at above address.

Fraser's Boilers and Condensers.—We have received lists giving illustrations and general description of the Fraser improved dry-back marine boiler, and Fraser's patent evaporative condenser. Details of construction, and diagrammatic views, are given in both cases. There is a photograph of a 1,000 H.P. size condenser, with casing plates removed, and of a 2,400 H.P. marine boiler. The makers are Messrs. John Fraser & Son, of Millwall Boiler Works.

Gas.—On 4th inst., a very serious gas explosion at Boston, Mass., killed seven people, injured many others, destroyed one tramcar, and damaged two others.

At Forest Gate, on 5th inst., an explosion occurred at a public house, owing to a leakage being sought with a naked light.

On 9th inst. an explosion took place at Argyle Street, Halifax.

Improved Röntgen Tube.—In our notice of the improved Röntgen tube last week, we omitted to say that the sole representatives for the Allgemeine Elektricitäts Gesellschaft, who are the patentees and manufacturers of this lamp are the Electrical Company, Limited, of Charing Cross Road. We understand that the London company has stocked the tubes for some time past.

Lining for Storage Battery Compartments.—The dirt and leakage of storage batteries have been a block to their progress in traction work, and it is not easy to fight against dilute sulphuric acid. In Hanover, where the battery system is employed as a storer of energy on portions of the trolley route outside the city limits, it serves as the sole motive power within city limits, as already described. The Standard Paint Company, through Messrs. Allut, Noodt & Meyer, of Hamburg, thus describe the system of acid proofing the compartment of the storage cells. The prime necessity is an

entire absence of metal in any form, and at Hanover a second bottom was put into the space to ensure this desideratum. Then all space to be covered must be dry, and the walls must be cleaned of dirt, oil spots, and this done, the second bottom, free from metal, is accurately fitted in, and fitted with a drain pipe opening. The second bottom is placed with a slope of 1 in 110 towards the drain. What is known as P. & B. composition is then coated upon the lower bottom. The underside of the second fitted bottom liner is similarly coated and pressed down on the old bottom, and weighted down thereon for four hours, to cause adherence. Next, all joints, holes and flaws are painted with the stuff, and filled up with the same in a less diluted form. Following this, the bottom and sides to a height of 100 mm. are painted with diluted stuff, again with same undiluted, yet again with undiluted composition, after which a lead box is put in and weighted down. This box is made of lead sheet 1½ mm. thick, with sides 100 mm. high. After fitting, the sides are soldered, and in 12 hours all the surfaces of the box are painted with dilute P. & B., and, when dry, twice with undiluted. Next, the P. & B. ruberoad felt, in pieces big enough to cover a side in one piece, are pasted in so as to form overlap joints. Before putting in it is well painted with undilute composition, and pressed to place with sticks. The corners are fitted with suitable strips, and in a few hours the whole is covered with a double coat of undiluted composition, the bottom is filled 2 mm. deep, and a hard India-rubber plate, 1 mm. thick, is placed over it. Generally, all openings should be well filled and painted in composition, and this done, a durable, acid proof insulation is claimed to be secured.

List.—Messrs. Goodbrand & Co., of Southall Ironworks, Strangeways, Manchester, are sending out a list printed in several colours, showing their fuel economiser for utilising the waste heat from steam boilers. There are also illustrations of their quadruple acting fire and boiler, feed and other pumps.

The Sydney Engineering and Electrical Exhibition.—The exhibitions held in 1883 and 1886 having proved so successful in affording exceptional opportunities for useful and instructive recreation, the Engineering Association of New South Wales, in conjunction with the Electrical Association of New Wales, have decided to hold a similar exhibition during the months of June, July, and August, 1897, and cordially invite the co-operation of manufacturers, engineers, electricians, mechanics, and others interested, in order that it may be carried out with success. In view of the great success attained by the previous exhibitions, and the vast strides that have been made during the past few years in engineering, and more particularly electrical science, it is anticipated, says the *Engineer*, that the proposed exhibition will considerably surpass the previous ones, and prove worthy of the engineering enterprise of the colony. By the courtesy of his worship the Mayor of Sydney and the City Council, the use of the exhibition building, Prince Alfred Park, has been granted free of charge for a period of three months. It is proposed to open the exhibition on June 26th, and for it to remain open during the months of July and August. The exhibition is intended to embrace engineering in all its branches, and the exhibits will consist of raw materials, manufactured articles, machinery and models (in motion and otherwise), drawings and photographs of all kinds relating to scientific, mechanical and educational works, in classified sections. No charge will be made for space allotted, but the executive committee reserves the right to limit the space of each exhibitor. The object of the exhibition being solely for the advancement of engineering science, and the promotion of a general and practical education therein, it will be non-competitive, but prizes and certificates of merit will be awarded to apprentices and students. Further information may be obtained from Mr. Edward Noyes, 34, Gracechurch Street, E.C.

Willing's Press Guide.—A copy of the 1897 issue of *Willing's British and Irish Press Guide* is before us. The lists of newspapers and other publications are, as usual, arranged in a very handy way, and the information is generally accurate.

ELECTRIC LIGHTING NOTES.

Aberdeen.—The electric lighting accounts for 1896 were submitted to the Gas Committee on 24th ult. The general balance-sheet shows that at December 31st, 1896, the assets were:—Works, less depreciation written off, £34,780 5s. 5d.; sundry debts outstanding, £2,234 13s. 11d.; and stores on hand, £666 19s. 6d.—total, £37,681 18s. 10d. The liabilities were:—Amount borrowed on mortgage, £23,650; amount of temporary loans, £9,500; sinking fund and interest, £1,405 7s. 6d.; reserve fund £253 3s.; amount due to sundry creditors, £949 17s. 6d.; amount deposited in security for current, £31; balance due to bank, £1,892 10s. 10d.—total, £3,768 18s. 10d. The net revenue account shows a total expenditure during the year of £2,847 6s. 9d., made up of interest on loans, depreciation on buildings and plant, sinking fund and interest, &c.; while against this has to be placed an income of £2,654 11s. 6d., made up of £435 0s. 9d. of a balance brought from the previous year's account, and £2,219 10s. 9d. of revenue for the year. This leaves a loss for the year of £192 15s. 3d., which falls to be charged against the reserve fund. The principal items of income were:—Sale of current, £4,126 6s. 10d.; public lighting, £209 8s. 5d.; rental of meters, £118 10s. 8d.; hire of engine and dynamo at Ballater, £92 5s. 10d.; and sale of motors, £32 10s. The quantity of electricity generated during the year was 236,649 units, and of this quantity 11,057 units were consumed in public lamps and 199,128 by private consumers. It was decided not to reduce the price of current during the present year, but the committee resolved to ask a remit from the Council to grant discount to large consumers and to entirely abolish meter rents. A report on the mains by the engineer was before the committee, setting forth the proposal to increase the electric light voltage from 110 and 120 to 210 and 440. The report was ordered to be printed and circulated amongst the members of the committee, and it was decided to consult Prof. Kennedy in regard to the proposed change. The committee had under consideration a proposal by Messrs. P. C. Middleton and Co. to erect a small electric light station in the west end of the city, and they also asked the sanction of the committee to erect overhead wires. The committee, however, absolutely declined to entertain the proposal.

Last week Mr. Johnston reported to the Town Council that the past winter had been a very busy time at the electricity works. The plant had been heavily loaded, and owing to the non-delivery of the new plant on order, all the power available was needed to get over the load. The progress of the undertaking was as follows:—Lamps coupled up during 1894 numbered 8,010; lamps coupled up during 1895 numbered 8,490; lamps coupled up during 1896 numbered 8,829. Total number of lamps coupled up is therefore 25,329. The capacity of the present plant, without any reserve, was 11,700 lamps alight at once, of which 11,500 were alight at once on December 31st, which was the heaviest load recorded. Up to the present none of the new plant had been completed; the boilers were now in course of erection, and the new 300-horse-power engine and dynamo was expected in Aberdeen next month. The buildings were practically completed. There would be no need for any increase of plant this year, unless the mains were extended to the west end, in which case it would be necessary to lay down another engine and dynamo. The new 300-horse-power engine would supply 4,800 lamps alight at once, and the new boiler power would be equal to running two of these engines. During the past year, Mr. Johnston proceeded, the price of the current had been reduced 1d. per unit, and was now 5d. Half the meter rents had also been taken off. There was every probability, however, that the committee would shortly recommend the Council to abolish meter rents entirely, and also to abate the price charged to large consumers of electricity. The accounts were approved unanimously.

Aberdare.—Sir Courtenay Boyle, Secretary to the Board of Trade, announces in the *London Gazette* that the Aberdare electric lighting order, 1894, has been revoked as from February 24th, 1897.

Alderley Edge.—At the last Council meeting the Clerk read some correspondence with the Alderley and Wilmslow Electric Lighting Company respecting the completion of the purchase of the electric lighting order, and, after some discussion, the draft was approved, and the Clerk was instructed to apply for the sanction of the Board of Trade, and arrange with the purchasing company's solicitors to complete the matter.

Battersea.—Last week the L.C.C. granted the Battersea Vestry loan of £13,900 for the purpose of an electricity station site.

Belfast.—The report of the Electric Committee as to their investigation of recent practice in the generation and distribution of electricity, was adopted by the Corporation last week. The various systems in operation in this country are described, and the engineer, Mr. V. A. H. M'Cowen says:—"In the foregoing particulars of the stations visited you will notice a similarity in a number of respects. Nearly 90 per cent. of the engines are of the high speed type, direct coupled to the generators. In the provincial stations visited Lancashire boilers are principally used, while in the city stations the greater number are of the water-tube type. The high cost of land and the necessity for quick steaming to meet fog demands explains to a certain extent the large use of the water-tube type boiler in London stations. In conclusion, after having had an opportunity of seeing the practice in the towns visited, both as to generation and distribution of electric current, I see reason to alter the general scheme recommended in my report of September 17th, 1896."

The Corporation has agreed upon the advice of their engineer to make a change of pressure from 110 to 220 volts, and have authorised him to effect this change accordingly, which involves an estimated expenditure to the department of £2,500.

Birkdale.—A Committee has been appointed by the District Council to consider the advisability of adopting electric lighting.

Bradford.—The statement made by the Mayor at Tuesday's Council meeting, regarding the electric lighting accounts for the year 1896, was very satisfactory. The total profit for the latter half-year was £4,000 odd, as against £2,293 in 1895. The net profit was £3,007, as against £1,506. The number of consumers had increased by 28 per cent., and the total units consumed was 477,342, as against 373,372. The total profits since the opening of the works in September, 1889, were £12,168, and after allowing £4,622 odd for depreciation, £7,545 remained as clear profit. The cost of production per unit was 3·269d., as against 3·928d. in 1895.

Bray (Ireland).—The Township Commissioners have received the following tenders for extensions to the switchboard at the electricity works. The four lowest tenders have been referred to Mr. Geo. M. Harriss, the electrical engineer, for report:—

	£
Messrs. Siemens, Bros.	435
Messrs. Easton, Anderson & Goolden	350
The Electric Construction Company	307
Messrs. Laing, Wharton & Down	273
Messrs. Johnson & Phillips	245
Edison & Swan United Electric Light Company, Limited	236
Messrs. John Fowler & Co.	229
Messrs. Evered & Co.	200

Bournemouth.—A special sitting of the Dorset Court of Quarter Sessions was held recently at Dorchester, to hear an appeal by the Poole Board of Guardians, as the Assessment Committee of the Poole Union, against the decision of magistrates sitting at Branksome reducing the assessment by the Guardians of the Works of the Bournemouth and District Electric Supply Company in the parish of Branksome. These were assessed by the Committee at £2,850 gross and £1,900 rateable value. Against this assessment the company appealed, and the magistrates reduced the assessment to £656 gross and £465 10s. rateable. Mr. Balfour Browne, Q.C., was leading counsel for the appellants, and Mr. Freeman, Q.C., for the respondents. A number of expert witnesses were called on either side, and the magistrates, among whom was his Honour Judge Philbrick, Q.C., having deliberated, the appeal was allowed, and the Court decided that the gross value of the property should be put at £2,190 and the rateable value at £1,460. The Court considered that the appellants should have costs, his Honour Judge Phillbrick adding that they had agreed that if the parties did not settle the costs they would fix them at 500 guineas. Mr. Freeman applied to the magistrates to state a case on the question of the principle involved. Mr. Balfour Browne submitted that if the magistrates sent up a case the Court above would say that it was a matter for the Sessions, as the question involved was not one of law, but of method of valuation. The Court declined to grant a case.

Burnley.—Mr. W. R. Wright, the electrical engineer, informs us that the Town Council at their meeting on Wednesday, last week, ratified the proposition of the Electric Lighting Committee to adopt a method of charge on Hopkinson's system, *i.e.*, £8 per annum per kilowatt of maximum demand, plus further charge of 2d. per unit measured by meter, or an alternative of 6d. per unit, with 5 per cent. reduction in each case for payment within 21 days of demand.

Canterbury.—Last week the Council discussed a proposal to engage counsel to represent them at the forthcoming Local Government Board inquiry *re* electric lighting. Eventually the matter was referred back to the Lighting Committee.

Cardiff.—The Mayor of Cardiff (Alderman E. Beavan), the deputy-mayor (Councillor Morgan), Alderman David Jones, Alderman Carey, Councillor Hallett, Mr. J. L. Wheatley (town clerk), Mr. Harpur (borough engineer), and Mr. Applebee (electrical engineer), visited last week electrical works at Manchester, Liverpool, and Blackpool. Those gentlemen represent the electrical lighting and electric tramways committee, and will in due course report their experiences to the Cardiff County Council.

Cardiff.—The proposal to light Cathedral Road electrically has been referred back to the Lighting Committee.

Douglas.—The Isle of Man Tramways and Electric Power Company, Limited, have under consideration the question of the lighting by electricity of the Douglas promenade from Derby Castle to the Victoria Pier, and of Victoria Street, Prospect Hill, Bucks Road and Woodburne Road, as far as Earl Terrace. The company have decided to submit an offer to the Town Council.

Dundee.—The Gas Committee will recommend the Council to light certain streets by means of 24 arc lamps (replacing 124 gas lamps). The cost thereof, and also of certain additions to the plant, will be £3,350. The electricity rental for the past 10 months was £3,438 11s., an increase of £334 2s. 7d. over that for the same period in 1895-96.

Edinburgh.—The Electric Lighting Committee of Edinburgh Town Council resolved last week to recommend that a sum of £4,050 be voted this year to the electric lighting reserve fund.

Hampstead.—The electric lighting accounts show that the estimated receipts for the ensuing year amount to £15,169, which, together with the estimated balance in hand on March 25th, make a total of £17,819. The estimated expenditure is stated as £12,360, and it is proposed to allocate the balance of £5,459 towards the formation of a sinking fund.

Harrogate.—It is anticipated that the electric supply will be available by about the middle of April.

High Littleton.—The Parish Council has resolved to ascertain the feeling of the ratepayers as to the lighting of the district by electricity.

Inverness-shire.—Messrs. P. C. Middleton & Co., of Aberdeen, have just put down an installation by which Rossal and Carroll, two mansions in the suburbs of Inverness, are lighted. An 11 H.P. oil engine, situated in the grounds, drives the dynamo.

Llandrindod Wells.—The Electric Light Company, having agreed to the terms suggested by the Council, it has been decided by the Council to withdraw the formal opposition which had been lodged against the provisional order now being promoted by the company.

Leyton.—According to the report presented to the District Council by the Lighting Committee on Tuesday, last week, there were 8,895 units generated during the month of January, of which 4,905 were sold, and the remainder used for public lighting. During the month of February there has been a satisfactory increase in the number of private consumers, in addition to which, the installation of the light in the main streets has been rapidly pushed forward, with the result that the number of units generated is noticeably on the increase.

Littlehampton.—The Rushington Convalescent Home, which has been built and endowed by Mr. Henry Harben, vice-chairman of the Prudential Assurance Company, and is to be opened on the 20th inst., is lighted entirely by electricity. The electric light station is placed 325 feet to the rear of the Home, and is fitted with boiler, dynamo, and engine, everything being in duplicate, so as to avoid as far as possible the chances of a breakdown. The building is lined with white glazed bricks throughout, and comprises boiler house, dynamo and engine house, workshop, accumulator room, coal house, and water heater. The whole of the laundry apparatus is worked by means of an electric motor.

Liverpool.—At last week's City Council meeting, Mr. Petrie said the cost of lighting Lime Street by gas was £733 per annum, but the cost of lighting it as at present by electricity was £466 per annum. The Council might take it that in any street where special lamps had been used, there was very little difference between the cost of lighting by electricity and the cost of gas. This year they would extend the main along a portion of Scotland Road.

Manchester.—The Council has agreed to the inclusion in the Corporation Bill of provisions to enable the Corporation to supply electricity beyond the limits of the city, by agreement with adjoining local authorities, and, further, to extend the powers of the Corporation in reference to the supply of electricity.

Mile End.—We understand that the Vestry has now decided not to oppose the application of the County of London and Brush Provincial Electric Lighting Company for a provisional order for lighting the district.

Municipal Electric Lighting in the States.—They seem to have some funny ideas across the Atlantic, not only as to what constitutes a municipal enterprise, but also with regard to the fundamental elements or principles of successful working. Quite recently one of our contemporaries from the other side thought it worth while asking the question, Whether municipal electric light plants *ever pay!* dealing with the subject from a negative standpoint, and more particularly in reference to an instance where success was claimed. The "municipal" element in this instance, however, appears to consist merely in the fact that the city in question installed the plant with borrowed money, and then allowed a company to operate it, the city paying a fixed rate for each public arc lamp per annum! Private lighting—both arc and glow—appears to be carried on at a loss, or next to no profit; so that the cost of public lighting must be high enough to pay all charges, inclusive of sinking fund. This is rather a novel mode, to our minds, of working a "municipal" plant, though, theoretically, one would say it is pretty much equivalent in results to such a system as that employed, say, in the City of London (always providing that ratepayers are identical with private light consumers), in the one case, profit on the private lighting makes up for any possible loss on a small charge for public lamps; in the other case, the public lighting rate is the backbone of the whole business. We wonder what American engineers and municipal authorities think of the Manchester City Lighting Station, or any other of the large number of public plants in this country—all of them paying, and many of them giving better working results than any company-owned affair seems able to do. Such a half-and-half sort of business as that outlined above, however, can hardly, we suppose, be taken to represent the true notion of "municipal" enterprise in the States; there seems but little local authority about it, except for the fact that the city credit is pledged to obtain the necessary capital. There are very few places willing to do this without also retaining and exercising a very full power of governing action, even in the merest details.

Newington.—Sir Courtenay Boyle, on behalf of the Board of Trade, had an interview with representatives from Newington in respect of the application for an electric lighting order. It transpired that since the last inquiry there had been another election of vestrymen, and that during the election the electric lighting question was fully discussed. The representation of the parish remained practically as before in favour of the municipal scheme for lighting Newington by electricity. Mr. Wheeler, Q.C., on behalf of objecting ratepayers, spoke against the scheme. Sir Courtenay Boyle said that, though the Vestry's case might appear weak on the compulsory area selected, he could not but consider Mr. Wheeler's case was even more so in asking the Board to ignore the wishes of the elected representatives of the parish. The Board had, as a result of the last inquiry, withheld their consent because it was not clear that the views of the Vestry were in accord with the majority of the ratepayers, but it appeared to him that, as the ratepayers had not materially changed the position of affairs at the last election, and the Vestry had again renewed their application, the Board would seriously consider the objections that had now been raised to the granting of this order, and would, in due course, communicate their decision to both parties.

Plymouth.—On Friday last the electric light was turned on at Shebbear College by the Governor. The plant has been laid by Messrs. Lord & Shand, and the engine (Hornsby's 12½ horse-power, oil,) was supplied by Mr. Glass.

Salford.—The Town Council has decided to light the various departments of the Town Hall by electricity, and tenders are to be invited for the work.

Swindon.—The District Council considered at great length last week a recommendation of the Electric Light Committee to adopt an electric lighting scheme, estimated to cost £25,000. The matter was ultimately referred back to the committee for further consideration.

Stretford and Withington.—A deputation, consisting of Aldermen Gibson and Higginbottom, Mr. W. H. Talbot (Town Clerk of Manchester), and Mr. C. H. Wordingham (the Manchester city electrical engineer), have had an interview on behalf of the Corporation of Manchester, in the presence of Sir Courtenay Boyle and other officials of the Board of Trade, with the representatives of the Urban District Councils of Stretford and Withington, respecting the applications of these authorities for electric lighting powers. The result of the conference was, says the *Manchester Guardian*, that the Board of Trade decided to sanction the applications of Withington and Stretford to secure their own provisional orders for electric lighting purposes, leaving it with them to open negotiations with Manchester at their discretion.

Teignmouth.—Mr. Headley, engineer at the St. Austell electric lighting works, appeared before the Teignmouth District Council, and explained the working of the low tension system, and how it could be applied to Teignmouth.

Wednesbury.—We hear that the Council has referred to a committee to consider the question of electric lighting.

West Ham.—In the Commons, on 4th inst., Mr. Duncombe asked the President of the Local Government Board whether, having reference to a correspondence which appeared in the public Press relating to the adjudication of tenders for an electric lighting installation at West Ham, and a resolution of the Town Council of West Ham to request the Local Government Board to make an inquiry into the circumstances, the Local Government Board had resolved to institute the inquiry requested. Mr. Chaplin said that the Local Government Board had no authority to institute the inquiry asked for, but the companies affected might either institute a prosecution themselves, or submit a statement of the facts to the director of Public Prosecutions.

Willesden.—The Urban District Council has informed the Hampstead Vestry that it has come to the conclusion that it is inexpedient to enter into any arrangement with them for the electric lighting of the High Road, Kilburn. The Willesden Council proposes to apply for a provisional order, and with that view has instructed the surveyor to report, after consultation with an electrical expert, as to the most suitable area to commence with, the High Road to form part thereof.

Winchester.—At the last meeting of the City Council the Special Committee submitted the draft transfer of the provisional order to the Winchester Electric Light and Power Company, Limited, and recommended that the seal of the Council be affixed thereto, and that steps be taken to obtain the consent of the Board of Trade to the transfer. Three amendments were proposed, having for their object the postponement of the adoption of the recommendation, which was, however, eventually carried by 12 votes to 3, with three neuter. A motion submitted by the Mayor, to affix the city seal, was carried by 12 votes to 4.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Air Brakes for Electric Cars.—The considerably increased car speed and weight (and therefore the greater momentum) now becoming common with the use of electric traction, whether on tramways or railways, exert a great influence on the type of brake employed. Obviously, it is too much to expect that the motorman shall be able or willing to operate day after day, and all day long, the same kind of hand brake that served quite well for slow running light horse cars. The strain of putting on a brake of this sort—of sufficient power to adequately stop a heavy fast running electric car—is excessive for any human being, and hence it has been found almost absolutely essential to employ power brakes. This will, of course, be still more the case when electric traction becomes more widely used on light railways and suburban lines. Electric brakes of one kind and another have been devised and tried, but they all appear to be somewhat complicated and liable to get out of order. In view of the continued experience that railwaymen have already had in air brake working, it is on the whole found preferable to use this type, and in order to avoid any other motive power than electric, an air compressor is coupled either direct to the car axle where there is room (not very often the case even with geared motors on a standard gauge truck, and certainly not found on narrow gauge trucks or with car axle armatures), or else a separate small motor, say 1 H.P., is used for driving the compressor, the entire arrangement in this case taking up very little space, not more than 2 feet in any direction, so that it may be packed away under one of the car seats. The first method has, of course, an advantage in the direct coupling, since the braking power, or at any rate, the air compressing power, is then a function of the speed; for that matter the air pump action alone would serve in ordinary cases to brake the car, the same principle being often employed on steam track railways as a "first resort" brake. The second device proves, however, quite satisfactory in working, and is more easily supervised, besides which there need seldom be any fear of the compressor-motor failing to act from loss of current, at any rate with a third rail supply, although this might be a possible danger with trolley wires and a contact not always maintained.

Birmingham.—We cull the following re the Birmingham electric tramway scheme from the *Birmingham Daily Mail*:—"The negotiations between the City Tramway Company and the local authorities have not been of the smoothest description. The correspondence of course has been courteous enough, but the members of the Council who have the matter under consideration have an impression that the directors of the company are inclined to take too much for granted. The Public Works Committee have not pledged themselves to any mode of traction up to the present moment, and will not do so until their tour of inspection on the Continent has been completed. The majority of the committee are in favour of electricity, and this circumstance seems to have been sufficient to justify the company in ordering 35 cars from America, together with rails, dynamos, and other requisites. Everything has been ordered from firms across the Atlantic on the ground that cheapness and despatch were not to be obtained here. I am in a position to state that this attitude towards local industries, combined with the premature orderings of cars, has touched the susceptibilities of some of the members of the committee. There is no desire to question the right of the directors to deal wherever they like, but the spirit which prompted them to discard local resources is not altogether palatable, and may lead to some friction ere the new system is started. I gather that some of the members of the committee have begun to look upon the conduit system as infinitely preferable to the overhead method."

Brighton-Rottingdean.—The Board of Trade has received an application from the Brighton and Rottingdean Seashore Electric Tramroad Company, for permission to erect an open work landing jetty, about 40 feet wide, commencing at a point about 73 yards seawards from the cliffs at Greenway's Gap, Rottingdean, with a pier head partly seaward of the tramroad.

Cheap "Beef."—One of the American electrical papers published, just before Christmas time, a lively rumour to the effect that trolley cars and bicycles had caused such a revolution in means of transit, that a small army of horses (100,000 we believe was the number stated, but a few odd thousands more or less don't matter), was practically running wild in one of the States alone, and that the farmers after disposing of all they could sell at any price, from 5s. to 10s. each, were hoping for a hard winter to kill off the rest. They must have been disappointed. Ten lbs. weight of carcase—all in—for a penny seems fairly cheap, even for sausage meat, so that we think the sausage makers, at least, ought to feel indebted to electricity for a fine supply of raw material. We never suspected, however, that the farm horse or market cart trotter had been replaced by single reduction motors to such an extent as this! *Perhaps* the story is just a shade exaggerated.

Continental Electric Tramways.—From the Allgemeine Elektricitats-Gesellschaft, of Berlin (London agents, the Electrical Company, Limited), we have received a bound volume got up in very elaborate style, and evidently with great care and at considerable expense, in which are described in German many Continental electric tramways which have been constructed by this company. The aid of the photographer has been lavishly enlisted for the purpose of illustration, and he has acquitted himself very satisfactorily. There are many full page photographs, some of them already familiar, showing various views of the Lübeck, Gera, Essen, Bilbao, Stuttgart, Halle, Kiew, Breslau, Chemnitz, Christiania, Dortmund, Plauen, Konigsberg, Altenburg, Strassburg, Genua (partly a tunnel line), Spandau, Keil, Leipzig, Nurnberg, and other places. The size of the book is about 12 inches by 9 inches, and there are 330 odd pages. Good paper, careful printing and strong binding have added to the utility of this interesting volume.

Coventry.—Messrs. Browetts recently wrote to the Stoke Council on behalf of the Coventry Electric Tramways Company, Limited, guaranteeing that the line, which it was proposed to run along the side of the Binley Road, in the parish of Stoke, should be fitted with single standards and brackets to support the overhead wires, of which they would submit drawings to the Council for approval. The chairman remarked that on receipt of this letter he signed the Council's consent to the Bill, as had been arranged at a previous meeting, and Messrs. Browetts had since informed him that they had made the provision a part of the Bill now before Parliament.

The City Council will sell a piece of land off the Stoney Stanton Road to the New General Traction Company as a site for a generating station for the electric tramway extensions.

Dublin.—Petitions are to be presented to the Board of Trade by residents in the districts served by the electric tramways, requesting that the speed of the cars now limited to 8 miles an hour, may be increased to 12 miles an hour.

Dundalk.—The Grand Jury which sat at Dundalk last week approved of the Dundalk Electric Tramway Company's scheme for an electric tramway from Dundalk to Blackrock, a seaside resort about four miles from Dundalk, and gave leave to lay the tramway along the public roads.

Electric v. Steam Railways.—The following is taken from *Money*:—"In view of the proposals to work all the London underground lines by electric traction, in place of steam, the result of inquiries which one of the American suburban companies has just been making is of some interest. The company sent out inquiries to all the electric companies with a view to computing the cost of working an 8-mile section by electricity. The line has easy gradients, and some 20,000 passengers per hour are required to be conveyed, at a speed 20 miles per hour. The estimates sent in show that by substituting electricity for steam the cost would be increased from £31,000 to £51,000 per annum. Nearly 100 locomotives could be purchased for the first cost of the electric generating plant and motors. The power station would entail an annual charge of £12,500, and 140 motors would be required, of which the cost would be £50,000. This seems to be prohibitive of 'conversion,' and unless

electricity could be supplied more cheaply on this side of the water than the other, the patrons of the 'Underground' will have to be content for the present to travel in a state of semi-asphyxiation from the sulphurous fumes of steam locomotion."

Germany.—Seven tenders were sent in for the construction of electric tramways in Frankfort, viz, by Messrs. Kummer and Co., Dresden, Messrs. Singer & Co., Berlin, Messrs. Siemens & Halske, Berlin, in conjunction with Messrs. Brown, Boveri & Co., Baden, Switzerland, the Union Company, Berlin, in conjunction with Messrs. Lahmeyer & Co., Frankfort, the Allgemeine Electricitäts Gesellschaft, of Berlin, Messrs. Schuckert & Co., Nurembourg, and the Westinghouse Electric Company, Pittsburg. The result of the adjudication has not yet been made known.

Glasgow.—The proposal that those members of the Tramway Committee who had not seen the overhead trolley system should go over to Dublin to see the lines working there, has been referred back to the Committee. With well-deserved irony Bailie Anderson suggested that the Committee ought at least to wait till the weather had improved before taking the suggested trip.

Highgate Cable Tramway. We understand that the famous Highgate Hill cable tramway, which is now being repaired, will be completed on or about March 19th. The Board of Trade has been requested to make the usual inspection.

London.—Accumulator Traction.—The London, Deptford and Greenwich Tramways Company has been considering the matter of accumulator traction, and on Tuesday the Highways Committee of the L.C.C. submitted the following recommendation:—"The London, Deptford and Greenwich Tramways Company has applied, under the provisions of Section 43 of the Southwark and Deptford Tramways Act, 1889, for the Council's consent to the experimental use of Ribbe's accumulator car, worked by electricity, on a portion of the company's line in Rotherhithe New Road, between Raymouth Road and the canal bridge, Old Kent Road. We see no objection to the experiment being made, and we recommend that the consent of the Council be given to the use by the London, Deptford and Greenwich Tramways Company of mechanical traction, other than steam, for the period of one year, upon the portions of the company's line in Rotherhithe New Road, between Raymouth Road and the canal bridge, Old Kent Road, and that the Board of Trade be informed that such consent has been given."

More Rail Bonds.—There is already a large diversity of rail bonds, each with its own particular advantages, though none possessing all the good points that one might imagine to be combined with tolerable ease. Presumably, patent rights stand in the way. One of the latest types consists of a *soldered* bond, that is, a bond whose heads are soldered into the rail webs; it appears to be made in two forms, the first, a long bond of the usual kind fastened outside the fishplate; the second, a short wide corrugated strip bond intended to go underneath the fishplate, being, indeed, held in position (apart from the soldering) by two of the fishplate bolts, which pass through the bond heads, made, therefore, hollow or ring-shaped in this case. There does not seem to be much practical value in the device in either of its forms. We cannot believe that a soldered joint will stand for any length of time between bond head and rail web, whilst there would be, we think, considerable difficulty in properly fixing and adjusting the second form of this bond, for use under the fishplate. A much better device is that lately described in the *Street Railway Journal*, which consists of a wavy strip of copper with solid heads passing, like the Chicago bond, through the rail webs, the whole lying quite well under the fishplate. The solid head, however, does not usually make a very good or large contact, at least it cannot be depended upon. We have not, as yet, come across a really good and reliable rail bond which can be called perfect, though the Chicago bond comes nearest so far.

Motor Cars.—From a Cardiff contemporary we understand that there is a movement in that town to abolish horse waggons and introduce motor-carts for scavenging purposes. Our contemporary says that "the new method of locomotion *has been successfully adopted* by several of the London Vestries." This is news indeed! We do not know of one London Vestry that has actually employed a motor car, much less have they been *successfully* adopted. One or two local bodies are considering the matter.

Power Plant Tests.—In a recent issue of the *Street Railway Review* there appeared a note on the results of a test made in the South Chicago City Railway power station the past fall, furnished through the courtesy of B. J. Jones, superintendent. The test was made to determine the working efficiency of a new direct connected cross-compound condensing Corliss, but included the whole plant from coal pile to switchboard. The showing is a splendid one for the general efficiency of the plant. The test lasted 24 hours, from 5 a.m. to the same time the following morning. The results are as follows:—

Total watt hours	5,260,000
Total pounds of coal used	27,100
Total pounds of water used	145,700
Water evaporated per pound of coal (actual condition), lbs.	5·37
Water per kilowatt hour, lbs.	27·69
Water per electrical horse-power hour	20·65
Coal per kilowatt hour	5·15
Coal per electrical horse-power hour	3·84
Cost of fuel per day	$12.87
Cost of fuel per ton	.95
Cost of fuel per kilowatt hour	.0024
Cost of fuel per electrical horse-power hour	.0018
Cost of evaporating 1,000 lbs. of water (actual conditions)	.0883

The boilers are the Stirling water tube type and Green economisers are employed.

Richmond (U.S.A.) Electric Tramways.—It is about ten years now since Mr. Sprague converted the Richmond Union line to electric traction, and showed the possibility of running ordinary street cars in regular service under all conditions of weather, track, and grade. The seed then sowed has brought forth the enormous crop that to-day has changed so much the aspect of traction methods; and the experience then gained has been of the utmost value, as will be clear from the changes in apparatus and details. It is, however, somewhat characteristic of American indifference to "perfection in particulars" so long as a primary end is achieved, that a new system of electric tramways only last year installed in Richmond, should still rely (so far as we can ascertain) upon overhead feeders throughout the principal street of the city—a street of width equal to 120 feet, and therefore well adapted to the centre pole canstruction employed. Some views of these poles lately shown in the American electrical papers, represent a capacity of as many as 14 or 15 overhead wires, for feeders, signalling, and other purposes. On country roads there is, perhaps, no great objection to overhead feeders, but there are very few English towns, we think, where such would be allowed in the main streets and thoroughfares. The trolley wires themselves are "swallowed" with an effort, growing less, it is true, as time goes on; but the heavy feeder wires will, in our opinion, have to go underground. The Coventry electric tramway does not altogether bear us out in this, seeing that an overhead feeder is there installed over part of the route, but it is not in the heart of the town.

Stockton.—The Town Clerk here has just presented a report with respect to the various clauses in the provisional order of the Imperial Tramways Company.

TELEGRAPH AND TELEPHONE NOTES.

Liverpool Telephones.—The National Telephone Company submitted to the Health Committee for approval a plan showing the system of underground pipes which, pursuant to a previous agreement with the Corporation, they propose to lay down in connection with the introduction of the twin-wire system. On the recommendation of the City Engineer (Mr. Boulnois) the plan was approved with one exception.

Stockholm Telephones.—We hear that 200 female telephone clerks employed by the General Telephone Company in Stockholm struck work on Tuesday.

The Buenos Ayres Telegraph Squabble.—The quarrel between the Argentine Government and the River Plate Telegraph Company of Monte Video, caused by the levying of a 57 cents gold rate per word on messages received by that company for Brazil which had come *vid* Galveston since 1892, still continues, and we understand the telegraph company's offices are still guarded by Argentine troops, and closed pending the submission of the company and the abolition of an extra tax imposed upon messages coming in any direction. In fact, the conflict is spreading, and all the company's offices are now prohibited from sending messages for Brazil from the North Atlantic by the Chili route. This cuts off Brazil from direct communication with North America, Mexico, the Central American Republics, Chili and Peru. It is said that the Buenos Ayres papers all strongly condemn the policy of the Government, except the *Prensa*, and the *Standard* of Buenos Ayres argues that such a precedent cannot be accepted, or the closing of banks, steamship companies, &c., may be similarly served, and the trade done by them pushed into protected channels. If the Convention, however, is to be of any value at all, and we think it has very little so far as the companies are concerned, the Argentine Government, as an adherent, cannot do anything else than seek to prevent the levying of unequal rates, and although the River Plate Company is in that very anomalous position of being a correspondent through a company which is not an official adherent, but which conforms to the regulations, it is very satisfactory to know that they are being held to the condition which devolves upon any company having lines connecting points between two adhering administrations.

The Telephone in Sweden.—Some interesting statistics are given about the telephone in Stockholm in the *Electro-techniker*, February 28th, 1897. The population of Stockholm is 205,000, and everybody in moderately good circumstances appears to have a telephone. The telephone is not used for business purposes only, but is found pretty generally in private houses, in the smallest cigar shops and newspaper shops, and in all sale rooms. In the houses of well-to-do families the rooms are connected by telephone, and the cook in the kitchen announces by telephone to the lady of the house in the drawing-room that dinner is ready. The steamboats on the canals are connected to the telephonic network on land. The central telephone exchange is a great tower of three stories, which was built in 1885. In this exchange 250 girls are busily employed connecting up subscribers. The average number of conversations per week is 100,000. The time required to connect up two subscribers is from 8 to 9 seconds. The length of the conductors connected to the central station is 10,200 miles. The installation of the telephone in Stockholm was carried out by a private company, which commenced work in 1883. In recent years the State has been constructing trunk lines, and has already about 4,000 subscribers. The longest telephone line in Sweden is from Malmö to Sollefted, a distance about 767

miles. The chief cause of the enormous spread of the telephone in Sweden is the low tariff. The cost to a subscriber for one telephone is £4 10s. per annum. This is lower than in any other country; for instance, in Copenhagen it is £8 10s. In Stockholm the tariff is still lower if 400 conversations per annum is not exceeded; in this case it is £3 3s. per annum, 1·36d. being charged for every additional conversation. On the trunk lines the tariffs are equally reasonable: for 5 minutes' conversation on a 60 mile line the cost is 2d.; from 60 to 150 miles it is 4d.; from 150 to 360 miles it is 6¾d.; and for all greater distances 13½d. What an impulse would be given to business if the Swedish rates were in force in this country!

The London Telephone Service.—In the House of Commons, last week, Mr. Bartley asked the Secretary to the Treasury, as representing the Postmaster-General, whether his attention had been called to the inefficient service of the Telephone Company in London and Westminster, and of its inability to supply persons with telephones; and whether he would take immediate steps to place the telephone service of London, which was now almost essential to modern business requirements, on a satisfactory basis.—Mr. Hanbury replied that the attention of the Postmaster-General had not recently been called to any inefficiency in the telephone service in London and Westminster, and he had no knowledge of the inability of the Telephone Company to supply persons with telephones. He understood that the company were making every effort to place the service on a satisfactory basis, and that the work of reconstructing the system on the metallic circuit principle was now nearly completed. The company stated that they hoped to be able to make arrangements for largely putting the lines underground, and that they would then be enabled to effect still further improvements.—Mr. Bartley gave notice that he would call attention to the subject on the Post Office vote.

Mr. Henniker Heaton, on Monday, asked the Secretary to the Treasury whether he was now in a position to state the general policy of the Government on the question of telephones, and their management and administration in this country. Mr. Hanbury replied that there was no change of policy to announce. The Government did not propose to take any steps to acquire, either by compulsion or agreement, the business of the National Telephone Company, which, as the hon. member was aware, was conducted under a temporary license from the Government. But the Postmaster-General would carefully inquire into any complaints of localities, and consider, on the merits of the case, what steps might be desirable to remedy the defect.

The Telegraph Wire Export Trade.—February has proved to be a comparatively quiet month in the export trade of this country in telegraphic wire and apparatus connected therewith, the total value for the month being returned at only £43,710, as compared with £62,120 in January last, and £109,840 in February, 1896. The total shipments during the first two months of the year have amounted to only £105,830, as compared with £167,064 in the corresponding period of 1896.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1895 ...	...
West Indies—		
Puerto Plata-Martinique	Dec. 19th, 1895 ...	...
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Grenada-Trinidad ...	Feb. 4th, 1897 ...	March 9th, 1897.
Jamaica-Colon	Feb. 6th, 1897 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Hong Kong-Macao	Jan. 5th, 1897 ...	...
Pernambuco-Ceará	Feb. 4th, 1897 ...	March 5th, 1897.
Assab-Massowah	Feb. 20th, 1897 ...	...

Telegrams are forwarded by boat.

Landlines.		
Trans-Continental line beyond Mazol	March 12th, 1896 ...	...
Carthagena - Barranquilla (Columbia)	July 4th, 1896 ...	...
Bagdad-Fao	March 3rd, 1897 ...	March 8th, 1897.
Saigon-Bangkok ...	March 4th, 1897 ...	March 8th, 1897.
	March 8th, 1897 ...	March 9th, 1897.

March 5th, 1897.—Telegrams for Ecuador subject to censure.

March 8th, 1897.—Telegrams for places in Uruguay, excepting Monte Video, must be written in plain (Spanish) language.

Telegraph Regulations.—In the 1896 Revision of the International Telegraph Convention and Service Regulations, just issued, the authors claim modifications have been introduced, such as additions to the service regulations printed in italics, and indication by footnotes of matter eliminated at the last Convention. The authors, consequent on the demise of Mr. Alfred Brasher, are Messrs. C. E. J. Twisaday and Geo. R. Neilson. The index seems to be more extended than usual, and there is an analytical table, which makes reference to various subjects more certain. To give some interest to this otherwise dry book, there has been inserted a treatise upon International Telegraphy and other matters. It is to be hoped that this book, in the future, will not be made too cumbersome by advertisements of a more or less useful and artistic nature.

CONTRACTS OPEN AND CLOSED.

OPEN.

Ashton-under-Lyne.—March 15th. The Corporation want tenders for the supply and erection of refuse destructors, boilers, dynamos, transformers, cables, lamps, accumulators, &c. Consulting engineers, Fawcus & Clirehugh, Temple Chambers, Brazennose Street, Manchester.

Bristol.—April 7th. The Electrical Committee invite tenders for the supply and erection of condensing plant, steam and exhaust piping, &c. Electrical Engineer, Mr. H. Faraday Proctor. See our "Official Notices."

Galatz.—March 27th. The Secretary of State for Foreign Affairs has received a despatch from H.M. Consul-General at Galatz stating that tenders are invited for the construction and working of a system of electric tramways over a length of about 13 miles of the streets in the town of Braila. The concession is for a maximum period of 35 years. Tenders to be sent to the office of the Mayor in Braila. Such further particulars as have been received may be seen at the Commercial Department of the Foreign Office any day between 11 a.m. and 6 p.m.

Islington.—March 23rd. The Vestry wants tenders for an 80 I.H.P. high speed engine, a 35 to 40 kw. alternator, and a 20 kw. continuous current dynamo.

Jamaica.—April 15th. The Privy Council invites applications for a license for the establishment and working of a system of rapid transit in Kingston and environs. Copies of the Tramways Law, 1895, and of local rules and maps of Kingston and environs may be seen at the offices of the Crown Agents for the Colonies, London.

Manchester.—March 16th. The Manchester, Sheffield, and Lincolnshire Railway Company want tenders for the supply of various articles during the year ended April 30th, 1898, including electrical materials, wire, and other sundries. Particulars of Mr. Longden, storekeeper, Junction Street Mills, London Road, Manchester.

Plymouth.—March 26th. The Corporation is inviting tenders for alternators, dynamos, boilers, condensers, pumps, accumulators, cranes, switchboards, mains, conduits, transformers, arc lamps and posts, and various other apparatus and machinery in connection with the electricity works of the Borough. Borough Electrical Engineer, Mr. J. H. Rider. We would draw the attention of intending tenderers to the supplementary notice signed by Mr. J. H. Rider, and appearing among our "Official Notices" this week.

Russia.—March 20th. Tenders are being invited by the Municipal Authorities of Ekakrinoslav, Russia, for the concession for the establishment and working of a central station for private and public electric lighting purposes in the town.

South Shields.—March 23rd. The Corporation want tenders for the supply of plant and the carrying out of work connected therewith, including the supply of cast-iron pipes and boxes, trenching and laying pipes, rubber covered cables and laying same, low tension cables and laying same, arc lamps, switches, transformers, incandescent fittings for street lamps. Borough Electrical Engineer, Mr. J. A. Jeckell.

Spain.—Tenders are at present being invited by the General Direction of the Spanish Post and Telegraphs in Madrid, for the supply of 42,000 porcelain insulators and 24,000 telegraph poles. Tenders to be sent to El Registre de la Direccion General de Correos y Telegrafos, Calle de la Carretas, 10, Madrid.

Spain.—March 14th. Tenders are being invited by the Municipal Authorities of Hernani (Guipuzcoa province) for the establishment of a central electric lighting station in the town. Water power is to be utilised. Tenders to be sent to El Secretario del Ayuntamiento de Hernani (Guipuzcoa).

Torquay.—March 13th. The Electric Light Committee is prepared to receive proposals from companies or firms willing to undertake the free wiring of houses and premises in the Borough.

Tunbridge Wells.—March 13th. The Corporation want tenders for the supply and erection of a 350 kw. alternator with engine combined. Borough electrical engineer, Mr. Boot.

Wells.—March 27th. The Lighting Committee wants tenders for the supply and erection of the plant required for the complete equipment of an electric light station and for the underground conductors, &c. Particulars from Dr. John Hopkinson, 5, Victoria Street, S.W. See our "Official Notices."

CLOSED.

Cheltenham.—The Lighting Committee recently ordered for trial, ten tons of each of the kinds of slack coal offered by Messrs. Williams & Co. at 7s.; Messrs. S. H. Harris & Co. at 7s. 3d.; Mr. A. H. Nott at 7s. 6d.; and Messrs. H. Workman & Co. at 7s. 6d. per ton.

The arc lighting of the Promenade is to be proceeded with forthwith and the engineer is bringing up a scheme for the electric lighting of Winchcombe Street as far as Pittville Gates.

Hammersmith.—For the wiring and fitting of the electricity offices and works for lighting purposes, the contract has been given to Messrs. Russell & Russell of Westminster, at £49 10s.

Islington.—The Vestry have accepted the tender of the Edison & Swan United Company for electrical stores for the ensuing year.

South Shields.—The tender of Mr. W. J. Robertson (£741) for the building of an extension to the engine house at the electricity works has been accepted.

NOTES.

A Large Canadian Water-Power Scheme.—Some weeks ago the members of the Canadian Society of Civil Engineers visited the gigantic works of the Lachine Rapids Hydraulic and Land Company, which are situated about seven or eight miles from Montreal, and were entertained at lunch by the contractors. The company is to supply the vicinity with water, electric light, and power. Some 260,000 cubic yards of rock have been taken out of the reclaimed bed of the river, the cribs have all been sunk, the foundations of all the power houses are completed, and the steel frames are receiving the finishing touches. The main dam will consist of 42 isolated masonry piers, 4 feet wide and 50 feet long. The power house, which will be built upon these, will be 40 feet wide and 1,000 feet long, the width being increased at the spots where the dynamo houses are erected. The turbine equipment consists of 66 improved cylinder gate wheels, each 54 inches in diameter. The working head under which these wheels will operate, will vary from 8 feet to 11 feet. The entire plant will develop at an average stage of water in the neighbourhood of 10,000 horse-power. The wheels will be placed in sets of six; that is to say, there will be 11 sections, each section consisting of six turbines geared to one jack shaft for driving one large generator, and each of these sections will be provided with an electro-mechanical governor for regulating the speed. The power will be transmitted from the turbines to the generator shafts by means of mortise bevel gears carefully finished. Each dynamo will have revolving fields and stationary armature, and the two parts will be so built that one can be moved relatively to the other, in order to give access to all parts for repairs. The construction will be such that this movement will be easily made when the two dynamos are set with their shafts parallel at 20 feet distance. They will have self-oiling and self-aligning bearings. Each dynamo will have a capacity of 750 kilowatts on a non-inductive load, and an approximate voltage of 5,000 volts. They will have 40 poles, and the speed will be 175 revolutions per minute. On this ratio the electrical output of the dynamos to the mechanical power on the shaft (including in this one-fourth of the mechanical power required for the exciter when feeding four dynamos), will be about 95 per cent. The dynamos will operate regularly in parallel, feeding into common bus bars, and when so operated on any load, each dynamo will carry its own proportion of the total load, assuming that the turbines are adjusted for equal outputs at the same speed. The six exciters will be direct current multipolar belt-driven dynamos, and each dynamo will be of a capacity to excite simultaneously the fields of the four alternators when they are running at 10 per cent. under the specified speed. It is expected that the machinery will be running in good order by the middle of May.

Water Tubes in Boilers.—A recent correspondent of the *Mechanical World*, Mr. W. Akhurst, makes some sensible remarks upon the cross tubes in the flue tubes of Lancashire boilers. He does not seem to hold much of an opinion of these expensive and useless adjuncts. We have long doubted their utility; looked upon as stiffeners, we think no good reason can be shown for them. They are like the studs in a chain. If of any good, a stud should be placed in each link. But cross tubes are placed in the strongest rings of a boiler furnace tube. The furnaces themselves are left free. Therefore why use them? Can a ½-inch rope be strengthened by splicing a three-quarter rope in its middle? Then cross tubes are causes of smoke. They break up and destroy nascent flames, and once extinguished, the gases do not readily flame again. It is urged they add to the heating surface; but of what use is a bit of extra heating surface at the expense of all the surface being soot covered, with a poor absorptive power? It is urged that the cross tubes break up the flowing gas. We doubt this very much. In a plain tube the flowing gases are just as likely to have a rolling motion, like a series of vortex rings, and to be successively in contact with the plates of the tube as when the inner core of gas is obstructed by a tube, and prevented from rolling. Moreover, the tubes prevent cleaning; they cause dust to lodge on heating surface instead of in the bottom flue, and are, in our opinion, quite an unnecessary expense, with no corresponding return under any conditions, for they stop the natural circulation which should take place in a Lancashire boiler. Their use has been due to the desire of boiler makers to sell extras at a cost which no doubt affords a better profit than the general profit upon a boiler, and it is wonderful to see how boiler makers cling to them, advise them, specify them, even when asked not to do so, and generally act as though the stability of their boilers depended upon them.

Distribution of Temperature in Geissler Tubes.—Mr. R. W. Wood has been measuring the temperature in different parts of the discharge in a Geissler tube. The results of his observations are published in the *Physical Review** (November-December, 1896). A special design of bolometer was used for making the measurements. The sensitive part of the bolometer consisted of a loop of wire supported inside the tube on the end of a rod, which passed downwards through a column of mercury to the outer air. The loop could thus be moved up and down the tube to any point between the electrodes. The terminals of the loop were, of course, on the outer end of the rod. It was found possible to draw curves showing the temperature at all points between the two electrodes. In the unstratified anode light, the temperature was nearly constant for the greater part of the column, rising to a maximum near the middle, and falling off as the dark space was approached. The maximum was usually found when the light was on the point of stratifying, and sometimes at higher pressures. On nearing the dark space a decrease of temperature was always observed. The temperature dropped very suddenly on leaving the anode light, reaching a minimum near the middle of the dark space; a rapid rise to a maximum taking place when the blue negative light was entered. In the stratified anode light, the temperature curve assumes a wavy form, the light discs being warmer than the dark spaces between them The dark space in front of the cathode was explored in a tube at a pressure of 0·1 mm. On entering the dark space the curve falls somewhat abruptly to a minimum, and then rises again rapidly as the cathode is approached. If the electric energy consumed in the tube is wholly converted into heat, Mr. Wood's experiments indicate a steep potential gradient in the negative light, a medium gradient in the positive light, and an easy gradient in the dark space; a result which agrees with what is already known.

The Production of Electricity by Chemical Means.—For some time E. Andreas has been engaged in investigating the behaviour of primary batteries, which depend, as regards their action, upon the continuous oxidation of hydrogen, carbon monoxide, &c. Although his results have been for the most part of a negative nature, they are none the less valuable on that account, inasmuch as it is often as useful to know that a thing cannot be done as that it can. During a portion of his investigation, he has been collaborating with Borchers, and together they have fixed upon the weak point in the batteries with which they have experimented. This consists in the use of electrodes, which become dissolved as the battery acts. They have both come to the conclusion that success with such batteries may only be secured by discovering and employing electrodes which do not pass into solution during the oxidation of the gas which is used in the battery; it remains therefore for themselves or others to discover and apply such electrodes. A full account is given of these later investigations in the *Zeitschrift für Electrochemie*, Vol. 3, pages 186 to 189.

* See also *Wied. Ann.*, 59, p. 238.

Roller Bearings for Street Cars.—The *Street Railway Journal* comments on the amount of ingenuity and money expended on devices to produce power economically, and the little attention paid to devices for rendering power unnecessary. Thus ball and roller bearings have been applied advantageously to many purposes, but the street railway people have neglected them. Some of the earlier attempts in roller bearings proved failures. This, our contemporary thinks, has exercised a deterrent effect upon such apparatus; but now that more attention can be given to such details, they ought to attract more notice. One of the more recent roller bearings is that of the Mossberg and Granville Manufacturing Company. It consists of a number of rollers of hard steel confined in a cage, for the purpose of maintaining them parallel, and in place. These rollers simply fill the space left between an axle and a bearing so much larger than the axle as to admit the rollers. Tested on a line from Pawtucket to Attleboro, the executive reported that the car did not use one-half the power of the other cars. The Browne & Sharpe Company report a saving of 90 per cent. in a rolling mill, and an ability to stand 20,000 lbs. per square inch of projected area of bearing. The bearing has been tested up to 10,000 revolutions per minute. A 40-inch fly-wheel of 130 lbs. weight was spun upon one of the bearings at this speed, and ran, when the clutch was slipped, for as long as an hour and a half fully. In another test with ordinary bearings under equal conditions, the pull to start two motors was for ordinary bearings 240 lbs., and 18·5 lbs. with the roller bearing. Again, with an electric test of two minutes, the absorption of power by the roller bearing was about as 11 to 20, the distance run as 1,000 to 636, the speed as 120 to 32, the time per mile 2 to 3¼, and the duration of motion after shutting off current 1 minute 42 seconds to 12 seconds. The enemy of the roller bearing is, of course, dirt. If protected from this, there is no reason to suppose they will not prove perfectly satisfactory. A train with roller bearings should not, if the foregoing figures are true, as they very likely are, require more than a mere fraction of the hauling power now required. Has any proper trial ever been made with such bearings in our railway services? We believe not. Yet, if made, it ought to very much reduce locomotive expenses, and prevent the enormous growth of size and weight in locomotives.

Fatal Accident.—On Wednesday last week Mr. C. H. Collinson, aged 29, mechanical engineer, of the firm of Collinson Bros., electricians, was killed by the fall of a girder at the Old Post Office Stores, Bradford. The jury found that the deceased had met with his death accidentally.

Fire.—On 5th inst. a fire occurred at the Telegraph School of the North British Railway Company in Edinburgh. Considerable damage was done to instruments by smoke and water.

Electricity and Electrical Vibrations.—At the Royal Institution on Saturday, Lord Rayleigh began a course of lectures on "Electricity and Electrical Vibrations." Lord Rayleigh proceeded to point out the analogy between inductive currents in two coils and effects that might be produced mechanically. Clerk Maxwell had argued there must be some mechanical connection between the two coils, seeing that what was done in one had an effect in the other, and the lecturer exhibited an arrangement to illustrate this conception. It consisted of an endless cord stretched over two pulleys, two other weighted pulleys being hung in the dependent bights. When one of the unweighted pulleys was revolved, the other unweighted one in response moved a turn or two in the opposite direction and then stopped, while the stoppage of the first pulley was accompanied with a slight movement of the second one, again in a reverse direction. This device formed an exact analogue to the induction of electric currents, the same mathematics being wanted in both cases. In conclusion, says the *Times*, Lord Rayleigh mentioned some of the applications of these induced currents, and explained how he had used the flame-like arc obtainable from them by means of a transformer for the oxidation of nitrogen and the isolation of argon, at the same time describing and showing at work his apparatus for the production of the last-named gas.

Consulting Electrician for State Institutions.—Governor Tanner is considering the advisability of appointing some competent electrical and mechanical engineer as the permanent adviser of the administration of the State of Illinois in remodelling the lighting and heating plants of the State institutions. Some of the plants are antiquated and poorly constructed. By substituting machinery and apparatus representing modern ideas of economy in fuel, in such cases, and rigidly inspecting and overhauling the construction work, it is thought, says the *Western Electrician*, that a great deal of money could be saved in operating expenses, and that, what is far more important, the danger of fire from electrical causes could be done away with in certain public institutions that are crowded with inmates. It is not intended to create a new office or a salaried place, but rather to specify some engineer to take charge of the work on a commission basis. Is there not room for similar appointments in this country also?

The Action of the Silent Discharge on Pure Substances.—At the last meeting of the Chemical Society, W. A. Shenstone communicated the results of some observations which he has been making on the properties of some highly purified substances. Amongst these we may notice the behaviour of oxygen. Upon comparing its behaviour under the influence of the silent discharge of electricity when saturated with water vapour, and when carefully dried, Shenstone obtained results which show that, contrary to the statement of previous investigators, oxygen is most freely converted into ozone when wet, and that well dried oxygen yields only a very minute percentage of ozone. The results obtained also show that the ozone in ozonised oxygen is far more stable in the presence of water vapour than in its absence. That is to say, the change by which ozone is converted into oxygen is very greatly retarded by the presence of moisture. Highly purified chlorine, when submitted to the silent discharge of electricity, does not undergo condensation.

Institution of Electrical Engineers.—The students of the above Institution will visit the works of the Electric Welding Company, Hendon Street, Pimlico, S.W., on Saturday, March 20th. Those desiring to join the party should at once give notice to that effect to the secretary of the Students' Committee (Mr. W. Bunn, 23, Oxford Road, Stroud Green, N.). As the party will have to be limited, applications will be dealt with in order of receipt. The party will meet on the 20th at the Institution of Electrical Engineers, 28, Victoria Street, S.W., at 10.15 a.m.

Acetylene Explosion.—On Wednesday morning, Charles Johnson, plumber, Egremont, Cheshire, was experimenting with an acetylene gas engine which he had constructed, when the machine exploded, and he received such shocking injuries about the head that he died in a few minutes. He had used the engine on Saturday, and was under the impression that all the gas had been exhausted. The deceased was explaining the construction of the machine to his wife when the explosion occurred.

The Royal Society.—The following paper was down for reading yesterday afternoon:—Mr. A. A. C. Swinton, on "Some Experiments with Cathode Rays."

Personal.—Mr. R. Stuart Hampson, M.I.E.E., has recently been promoted from the position of telegraph superintendent to the Manchester, Sheffield, and Lincolnshire Railway Company, which post he held under the control of the engineer-in-chief, to that of electrical engineer to the company, responsible direct to the general manager. Mr. Hampson is president of the Railway Telegraph Superintendents' and Electrical Engineers' Conferences.

Mr. T. Cooper, M.A., Assoc.M.Inst.C.E., is vacating his post as distributing engineer to the Vestry of St. Pancras, having accepted the appointment of manager and engineer to the Cox Thermo-Electric Company, Limited, St. Alban's, Herts.

The Hon. Geo. V. Peel, who was elected to the board of the Eastern Extension, Australasia, and China Telegraph Company, Limited, on March 4th, is the secretary of the Gold Standard Defence Association and a director of the Stock Conversion and Investment Trust, Limited.

Shock Fatality at Hampstead. — On Wednesday morning Dr. G. Danford Thomas held an inquest at Hampstead Dispensary Hall on the body of Harry White, aged 35, of Gardnor Road, Hampstead, an electrical jointer, in the employ of the Hampstead Vestry's electric lighting department, who met with his death last Saturday in one of the street sub-stations of the parish. Mr. Arbuckle, factory inspector, represented the Home Office; Mr. A. P. Johnson, solicitor, Vestry Clerk, represented the Vestry; and amongst those present were: Mr. C. H. Reed, Chairman of the Electric Lighting Committee of the Vestry, and other members of the Vestry, and Mr. G. H. Cottam, chief electrical engineer. Thomas Gill said that he was a jointer, engaged in similar work to that of the deceased. On Saturday morning it was part of their work to clean out the transforming chamber of the sub-station in Lyndhurst Gardens. The deceased went down a ladder, and when he had nearly reached the bottom he put one foot on the electrical transformer itself, the other foot being on a rung of the ladder. Suddenly he assumed a strained position, and almost immediately fell over the ladder. Witness did not go down the ladder to his assistance, but went to the central station in Finchley Road, five minutes' distance from the spot, and told the engineer what had happened. Harold Woodall, assistant engineer, said that, after turning the current off, he went to the sub-station. Deceased was lying at the bottom of the chamber lifeless, and a hole had been burnt in one of his boots. An examination of the chamber showed that the insulation of one of the wires had broken down, but that did not account for the accident, because the "earth wire" was sufficient to carry off all the current from the transformer. By the Coroner: A new danger had arisen, which would have to be met in some way. This was an unheard-of accident. Edward Sayer, another assistant, and Mr. Cottam also gave evidence. The latter said that the transformer chamber was built in conformity with the regulations of the Board of Trade. Major Cardew had inspected the chamber since the accident, but could not say what was the cause of it. He had made certain suggestions, which had since been carried out. No doubt the "earth wire" failed. [How are these earth connections really made?] Dr. W. Heath Strange said that death must have been instantaneous, and a verdict of Accidental Death was returned.

Presentations.—On 4th inst. the employés of the Dublin Electric United Tramway Company presented Mr. Maher, traffic superintendent, with a gold watch and an illuminated address on the occasion of his transfer on promotion. Mrs. Maher was also the recipient of a biscuit barrel and umbrella.

A New Phosphorescent for X Ray Screens.—Dr. F. S. Kolle describes in the *Electrical Engineer*, N.Y., a method of preparing a new substance which has been introduced by Dr. Van Melckebeke, and is said to be more sensitive to the Röntgen rays than the platino-cyanides, or any of the other substances hitherto used on phosphorescent screens. The name of this substance is oxyfluoride of uranium and ammonium, and its chemical formula is $Ur_2\ O_2\ Fl_2\ 4\ N\ H_4\ Fl$. To obtain the best results, the oxyfluoride should be prepared as follows:—Dissolve 1 ounce of uranium nitrate in 4 ounces of water, heated to boiling in a porcelain evaporating dish. The uranium salt dissolves readily, leaving a straw-coloured liquid. To this add gradually one half ounce of ammonium fluoride, and allow the mixture to boil a few minutes; fumes of ammonium nitrate will be given off. The solution, which should not contain any sediment, is then set away to cool and crystallise. The crystallisation takes place in about an hour, when the liquid will have lost its yellow colour, and appears clear, like water. At the bottom of the dish will be seen a yellowish sediment, not unlike flowers of sulphur, which when examined by the microscope is seen to consist of octahedral crystals. The perfection of the phosphorescent property depends on the perfection of the crystallisation. The liquid above the sediment is decanted, and the latter washed two or three times with cold water, to remove all nitrate of ammonium. The oxyfluorides are insoluble in cold water, though readily soluble in hot water. The sediment may then be collected and dried on filtering paper. The crystals when dry can be mounted with flexible collodion or gelatine, as in other screens.

More Capital for the London Electric Omnibus Company!—We understand from the daily Press that although it is only a few months since the London Electrical Omnibus Company was floated, a circular is already going the round announcing the issue of new shares. After referring to the achievement of putting one experimental omnibus on the streets, the circular says: "You are aware that the ordinary shares of the company carry a liability of 10s. per share, which the directors can call up in sums of £5,000, but it has been suggested that several of the shareholders would rather avail themselves of the opportunity of increasing their holding in the company by applying for a fresh allotment of shares than pay up the whole outstanding liability on the shares which they now hold. Before, therefore, determining whether to make a call or to go to the public for capital, it has been resolved to give the shareholders and their friends an opportunity of subscribing among themselves for an additional 50,000 ordinary shares of £1 each at par. When the company is fully working, and paying a good dividend, the shareholders who avail themselves of this opportunity will thus reap the advantage." Surely it is high time that the public were put in possession of some definite statement as to how the money already subscribed has been spent, and a complete programme with properly estimated expenditure and receipts should also be forthcoming, before any more money is subscribed.

Lectures.—Mr. R. A. Grigg lectured before the Liskeard Literary Institution on Tuesday last week, his subject being "The Development of Electricity."

At a meeting of the Horwich Scientific Society last week, Mr. J. A. Gee gave a lecture on "Electrolysis."

Before the Newcastle Association of Students, in connection with the Institution of Civil Engineers, Mr. H. W. Appleby read a paper last week at the Durham College of Science on "The Application of Electricity to the Royal and Mercantile Marine."

General Electric Company's Staff Dinner.—On Saturday evening last, the annual dinner of the company to its staff took place at the Holborn Restaurant. Many friends of the principals had been invited, and after a most enjoyable entertainment, graced by the presence of a few ladies, and interspersed with a few capital speeches, the tables were cleared, and a programme of music by excellent artistes, including an exhibition of the "Animatoscope," was rendered. The evening, apart from climatic conditions, was one worthy to be remembered from the friendliness exhibited on all sides; but as the function was entirely one of a social character, it would be out of place to mention names, or in any way attempt to record speeches. One or two of the latter by the staff certainly evidenced some ability in this direction, and exhibited in a marked manner thoughts well expressed; this we should of course expect to find in those chosen to represent in any capacity the enterprising principals.

Improvements in the Manufacture of Alkaline Phosphates and Caustic Alkali.—At the Chemische Werke, Biebrich-on-Rhine, a method of manufacturing alkaline phosphates and caustic alkali is now being conducted electrolytically. Concentrated solutions of phosphoric acid and of a soluble alkali salt, such as sodium nitrate, chloride, or sulphate, separated by a suitable diaphragm in an electrolytic cell, are electrolysed to obtain in the anode compartment nitric or sulphuric acid or chlorine, as the case may be; and in the cathode compartment either a mono-, di-, or trisodium orthophosphate. The process may be interrupted at the proper time to obtain any one of these salts. A carbon anode and a lead cathode are preferably employed. When nitric acid or chlorine is produced, it may be recovered by heating the solution. To obtain a caustic alkali, the sodium or potassium phosphate, obtained as described, is treated with caustic lime, calcium phosphate being produced as a by-product.

Subject Matter Index to Wiedemann's Annalen.—This long expected index has just been published. It covers volumes 1 to 50 (1877 to 1893), and has been prepared by Prof. Dr. G. Meyer and J. Stöckle, of Freiburg. The price is 7 marks, and it can be obtained from I. A. Barth, Leipzig.

Molecular Harmonics.—The fact that the spectrum of an elementary substance consists generally of a considerable number of lines, shows that the molecule must emit waves of differing frequencies. It has been found that the law connecting these frequencies is not the same as for the vibrations of a stretched string or other simple elastic body. Balmer was the first to propose a simple formula for these molecular frequencies; if r_0 is a constant, the frequencies of all the hydrogen lines can be represented by Balmer's formula,

$$r = r_0\left(1 - \frac{4}{m^2}\right),$$

where for m we must put successively 3, 4, &c.; and lines have been observed as far as $m = 15$. r_0 is called the convergence frequency, as it is that to which the vibrations approach as m increases; the slowest vibration of the series is called the "fundamental" frequency. For the spectra of the alkaline metals, Kayser and Runge have shown that the vibration frequencies may be represented by means of three series of the form,

$$r = A - \frac{B}{m^2} - \frac{C}{m^4} \ldots\ldots$$

the fundamental in each case being given by $m = 3$. The first, or principal series, has lines which are single in the spectrum of lithium, but double in the other cases, the components separating further and further as the atomic weight increases. The two supplementary series consist of lines which easily widen and show the remarkable property that the convergence frequency, A, has nearly the same value for both supplementary series. A new and exceedingly simple law has been discovered by H. Franklin Parsons (see *Nature*, December 31st, 1896), which he enunciates as follows:—If we subtract the frequency of the fundamental vibration from the convergence frequency of the principal series, we obtain the convergence frequency of the supplementary series. By means of this law, Mr. Parsons predicts the existence of lines that have not yet been discovered, in the spectra of certain elements. In the case of cœsium, for instance, the fundamental vibration lies in the infra red, and has not been observed, but by means of this law its position may be predicted. The supplementary series have not been observed in the spectrum of hydrogen, but the new law shows that if they exist they must lie in the infra red, and Mr. Parsons has predicted their position.

Institution of Junior Engineers.—The third annual conversazione of the Institution of Junior Engineers was held last Saturday night, at the Westminster Palace Hotel. The guests were received by the president and his wife, Mr. and Mrs. A. R. Binnie, and by the chairman and his wife, Mr. and Mrs. H. B. Vorley. Through the courtesy of the Electrophone and the National Telephone Companies, the members and their friends were enabled to hear what was going on at various theatres. In the pure science section Prof. Greenhill, F.R.S., described his algebraic spherical catenaries, which had been calculated and drawn by Mr. T. Dewar, who, with the aid of the stereoscope, showed the results obtained; Mr. J. Macfarlane Gray exhibited the multiplying machine which he had devised for use in these calculations. Mr. R. W. Paul gave a display of animated photographs in the electric arc lantern room, and there were various other attractive items in the programme. There were short concerts of instrumental and vocal music.

Vacant Posts.—An instructor in electrical engineering and telegraphy is required for the Ceylon Technical College. His principal duties will be the training of telegraph and telephone operators for the Government Postal and Railway Departments. For particulars as to salary, qualifications, &c., see our "Official Notices."

The Southampton Corporation want a clerk of works for six months in connection with the electric lighting station buildings contract. Salary, 2½ guineas per week. Application on or before 15th inst. to Mr. G. Nalder, Town Clerk.

Electricity in Surgery.—An electrical department has been in existence for about six months at the Aberdeen Infirmary. The *Edinburgh Evening Dispatch* has an article on the apparatus in use. The electrical baths are largely used in the treatment of paralysis, and with great satisfaction.

The Institution of Civil Engineers.—At the ordinary meeting, on March 2nd, it was announced that 10 Associate Members had been transferred to the class of Members, and 21 candidates admitted as students. The monthly ballot resulted in the election of 1 Member and 44 Associate Members.

The Blot Accumulator.—Amongst new secondary cells which have lately been brought under the notice of the public, we have described that of M. Blot. The plates of this accumulator are made of strips of very thin lead, which are arranged in shuttles, a number of the latter being soldered to a lead frame. It is evident that a cell of such a description, offering a very large surface, will give a comparatively high capacity; but judging from past experience, it is hardly to be expected that this accumulator will, in continued use, prove better than its predecessors of a similar nature. The use of thin corrugated lead strips is old, one of the first accumulators, that of Kabath's, having been constructed on very similar lines. Unfortunately the thin lead strips on the positive electrodes soon became thoroughly oxidised, and were not only rendered useless, but as they were liable to break off, could cause short circuits. One of the illustrations in the *Engineer* of last week, which also appeared in the Review over a year ago, shows a half shuttle, that is to say, one end cut off. This, we presume, is done for the purpose of allowing the strips to grow without warping. The electrical contact of the strips does not appear to be good, there not being enough contact. This is clearly proved by the discharge curves, which show a more rapid fall of capacity with high discharge rates than one would expect, considering the large surface of the plates. The capacities at different discharge rates, down to 1·8 volts, are shown as follows:—

At 1·06 amperes per kilo. of	+	and	−	electrode	11·6	amp.-hours.
„ 2	„	„	„	„	10	„
„ 3	„	„	„	„	9	„
„ 5·1	„	„	„	„	6·37	„

At a discharge of 8·6 amperes, the starting E.M.F. is only 1·8 volts, and drops in less than half an hour to 1·5 volts. Now in a Planté cell, offering the same surface, but in which the mechanical and electrical arrangement is more perfect, there is not such a considerable difference in the capacity between the higher and lower discharge rates. The capacities, as they stand, are surpassed by many other existing types of accumulators.

Memorial to Galileo Ferraris.—The City of Turin feels bound to award to the late illustrious *savant* a memorial worthy of his name, and of the services which he has rendered to science. A general committee has therefore been formed to open an international subscription for erecting at the Royal Industrial Museum of Turin, a permanent monument commemorating his scientific and industrial achievements. The general committee at its session of February 24th, has appointed an executive for the collection of subscriptions. The president of this executive body is the Deputy Fada, and the secretary Monta, who will be prepared to receive and acknowledge all subscriptions forwarded to him, care of the Cavalier Zappata, municipal treasurer of the City of Turin.

What's in a Name?—A correspondent writes:—It appears that the English speaking Americans call the man who drives a motor car a motoneer or mutineer; the French nation calls him a wattman, or watthomme. We think a more appropriate name would be an Ohmer, or Homer, if the cockney prefers it. Some philologist may in future generations find that Homer is derived from Homo, a man, and Erg, a unit, or from Hohm, a unit or Englishman's castle, and erg a contraction for iceberg. So languages are made in this civilised age. Mho has nothing to do, however, with the broken tablets of Mount Sinai.

Fatality at Rosario.—Recently an individual in Rosario got up one of the electric light poles so as to reach the balcony, and thus get into his house. Chancing to come in contact with the high tension wires, he was immediately killed.

Appointment.—Mr. Arthur J. Fuller, of London, has been appointed electrical engineer at the Ayr Electricity Works, at a salary of £200 per annum.

A Preventive for X Ray Burns.—Dr. Danforth Cole has come to the conclusion that the sores produced on the body by long exposure to the X rays are not due to the X rays themselves, but to static electrical discharge which accompanies them. When powerful beams of X rays are used, these painful effects are often produced on patients subjected to a single exposure. Following up his theory, Dr. Cole interposes an aluminium screen between the source of the rays and the patient's body. In the result, he says, the patient is completely protected from the inflammatory action of the rays. Another investigator says that no burns are produced by tubes excited by an influence machine instead of an induction coil, but these results have not yet been confirmed by other experimenters.

The Metric System.—Mr. A. S. Gordon is a proud man to-day. He has discovered a grand way of celebrating the Record Reign, to wit, the adoption of the metric system without further delay. Mr. Gordon's letter is of the *Parturiunt montes nascitur ridiculus mus* type of writing, and contains phrases about the intellectual faculties of our great nation, &c. All this is sheer nonsense. There are no difficulties in the way of the metrical system of the kind he and his school of thought seem to fear. Such difficulties as there are are those of convenience, to which surely the metrical system cannot lay much claim, and of hard facts in the way of existing patterns, &c. We cannot well take on the metrical system unless in co-operation with America and all the rest of the Anglo-Saxon peoples. We fear Mr. Gordon has rushed into print without much thought. These metrical cranks all seem to have gotten hold of some old page of weights and measures in an old arithmetic, and got confused between their hogsheads and firkins, instead of remembering that, for practical purposes, we have come down to the pound and ton. True the gas companies sell coke by the chaldron, which no one knows; but then a gas company is—well, we all know what truthful things gas meters are, and "like master like meter."

NEW COMPANIES REGISTERED.

British Cinematographe Company, Limited (51,461).—Registered March 1st, with capital of £20,000 in £1 shares (500 deferred), to adopt an undescribed agreement for the acquisition of certain existing inventions to exhibit the cinematographe, and to carry on the business of electricians and mechanical engineers. The subscribers (with one share each) are:—R. Wynne, 175, Piccadilly, W., gentleman; G. B. Goffin, 31, Salcott Road, Wandsworth Common, accountant; C. N. Foreman, 178, High Street, Lewisham, solicitor; W. Godward, Chase Green Avenue, Enfield, accountant; J. Wilson, 73, Mostyn Road, Brixton, writer; J. H. Connolly, 42, Sandmere Road, S.W., writer; J. Hutchins, 91, East Dulwich Grove, S.E., gentleman. The number of directors is not to be less than four nor more than seven; the subscribers are to appoint the first; qualification 100 shares; remuneration £1,000 per annum, divided. Registered by Lumley & Lumley, 37, Conduit Street, W.

Martin Noiseless Safety Motor Syndicate, Limited (51,467).—Registered March 2nd with capital £24,000, in £10 shares, to adopt an agreement with W. D. Pitt and F. Farrant, and to carry on the business of motor manufacturers, cycle manufacturers and dealers, electricians, engineers, machinists, fitters, founders, &c. The subscribers (with one share each) are: W. D. Pitt, 23, Coleman Street, E.C., contractor; F. Farrant, Goldsmith Building, Temple, barrister; E. S. Brown, 5, Mandalay Road, Clapham, secretary; G. W. R. Lowe, 45, Seymour Place, W., book-keeper; J. W. Cawdery, 73, Archel Road, West Kensington, engineer; J. T. Sullivan, 483, King's Road, Chelsea, cigar importer; F. W. Walter, 153, Walmer Road, Notting Hill, W., clerk. Registered without articles of association by J. J. Chapman, 13, Clifford's Inn, E.C.

United Industrial Corporation, Limited (3,448).—Registered at Edinburgh, on March 6th, with capital £100,000, divided into 100,000 shares of £1 each, to act as principals or agents in the sale, purchase, or dealing with industrial concerns, loans, railways, gas, water, electric mining and other works, and to carry on the business of banking in all its branches. The subscribers (with one share each) are:—W. Hatcher, 3, Broomells Terrace, Clapham, London, valuer; W. Wackden, The Elm, Croydon, Surrey, tea merchant; J. Larkin, 37, Cromwell Road, Wimbledon, newspaper representative; W. Hauxwed, 9, Luxor Street, London, S.E., merchant; H. Jackson, 117, Coldharbour Lane, London, S.E., gentleman; T. Cassarn, 49, Hanley Road, Stroud Green, N., gentleman; R. Hollis, 50, Long Lane, London, E.C., gentleman. The directors to be afterwards appointed; qualification 200 shares. Registered by Anderson and Green, S.S.C., 28, Queen Street, Edinburgh.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Electro-Chemical Company, Limited (40,496).—This company's annual return has just been filed. The capital of £200,000, in £5 shares (26,000 preference), has been fully taken up, and all the ordinary and 5,000 preference are considered as paid. £5 per share has been called on 12,710 preference, and £1 per share on 8,290 preference, and £71,840 has been paid.

Electrical Advertising Syndicate, Limited (33,896).—The registered office of this company was, by notice dated January 6th, removed from 11, King William Street, E.C., to 61, Gracechurch Street, London, E.C.

London Electrical Cab Company, Limited (50,104).—This company's statutory return was filed on February 23rd, when 62,523 shares were taken up out of a capital of £150,000, in £1 shares; £1 per share has been called, and £61,223 10s. paid, leaving £1,299 10s. in arrears.

Ernest Scott & Mountain, Limited (32,760).—The annual return of this company has just been filed. The capital of £70,000, in £10 shares, has been taken up in full, and 2,000 shares are considered as paid; £6 5s. has been paid on 2,818, and £10 per share on the others. £37,432 10s. has been paid, including £4 10s. received in connection with the forfeiture of one share.

Epstein Electric Accumulator Company, Limited (34,528).—This company's annual return was filed on February 18th. The capital is £101,000, in £1 shares (of which 1,000 are founders'); 1,000 founders' and 70,307 ordinary have been taken up, and £1 per share called and paid on 300 ordinary shares, while the rest are considered as paid.

Elmore's American and Canadian Patent Copper Depositing Company, Limited (35,671).—This company's annual return was filed on January 26th. The capital is £200,000 in £2 shares (65,000 priority and 35,000 deferred); 44,788 priority and all the deferred have been taken up, and the latter are considered as paid: £2 per share has been called on the others, and £86,044 15s. has been paid, leaving £3,531 5s. in arrears.

CITY NOTES.

House-to-House Company.

The various incidents in the year's work have been already notified at considerable length in these columns, and nothing remains to notice but the cost of production, and the following table gives the cost per unit:—

	1896.	1895.
Total capital invested	£133,788	£102,380
Number of units sold	643,693	476,714
Number of lamps connected ...	55,265	44,162
Revenue from sale of current ...	£16,266	£14,390
Net revenue	£9,032	£6,841
Average price obtained per unit ...	6·04d.	7 24d.

Cost of Production.	£		Per unit.	1895.
Coal	2,664		·99d.	1·67d.
Oil, waste, water, and engine room stores	335		·12d.	·32d.
Salaries and wages at generating station	2,058		·76d.	·94d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	678	(Works' cost 2·12d.)	·25d.	·28d.
Rates and taxes	860		·32d.	·26d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges and insurance	1,793		·68d.	·71d.
Depreciation of buildings and plant account	—		—	—
Renewal fund account	—		—	—
Total	£8,388		3·12d.	4·18d.
Not included in above.				
Remuneration to trustees.. £21				
Depreciation £2,600				
	2,621			
Total ...	£11,009			

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	16,266	0	0	6·04d.
Meter rents	1,083	0	0	—
Other items	134	0	0	—
Total	£17,483	0	0	6 04d.

Total cost per unit (exclusive of depreciation and rene accounts), 3·12d.; works' cost, 2·12d.

The Brush Electrical Engineering Company, Limited.

The interim report to the shareholders for half-year ended December 31st, 1896, states that the works at Loughborough have been well employed, the volume of orders received during the half-year having been above the average of the past few years. The company's "Universal" engine is steadily growing in favour with buyers. Numerous orders have been received during the six months under review, and the engine has been put to work in several important installations, among which may be mentioned the Wandsworth, Windermere, and Oswestry electric lighting central stations, Messrs. W. T. Glover & Co., Manchester, and elsewhere. The new alternating current dynamo referred to in the last annual report has been completed, and the tests made have proved very satisfactory. The company hold in Great Britain the patent rights for this type of dynamo, which is being largely and increasingly used on the Continent of Europe. Progress has been made with the settlement of outstanding accounts with the City of London Electric Lighting Company, and further payments on account have been received. The necessary initial steps have been taken to give effect to the resolution of the shareholders to write £1 per share off the ordinary shares of the company. Mr. J. S. Raworth, lately joint manager and chief engineer of the company, has resigned his position, and has been elected a director, and also consulting engineer of the company. Mr. Percy Sellon has been appointed general manager, Mr. W. M. Mordey, consulting electrician, and Mr. C. E. Hodgkin, works' manager at Loughborough. The requisite notice has been given by advertisement that £26,770 of the company's second debenture stock will be drawn for repayment on October 1st next. This will leave a balance of £50,000 second debenture stock outstanding. The directors do not propose to declare an interim dividend, preferring to await the result of the complete financial year.

Commercial Cable Company, Limited.

The report of the board of directors for the year ending December 31st, 1896, states that the gross earnings, including interest from investments, amounted to $2,019,255, being an increase of $9,517 over 1895. The expenses amounted to $842,690, an increase of $48,349, which was principally due to cable repairs, eight repairs having been made during 1896, as compared with five of the previous year. The balance of earnings over expenses for the year amount to $1,176,565, out of which have been declared dividends of 1¾ per cent. for the quarters ending March 31st, June 30th, September 30th, and December 31st, together with a bonus of 1 per cent., making total dividends of 8 per cent., which have absorbed $800,000, and left a balance of undivided profits at the end of the year of $376,565; this has been added to the amount standing to the credit of profit and loss account for the previous year, making the balance of undivided profits carried forward $846,678. The reserve fund has been increased by a further amount of $250,000, which has been invested in first mortgage bonds of the Commercial Cable Building Company, secured by valuable real estate in New York City. The amount now standing to the credit of the reserve fund is $2,042,820. The company's accounts have been audited by Messrs. Deloitte, Dever, Griffiths & Co.; a similar yearly examination will be made in the future.

The County of London and Brush Provincial Electric Lighting Company, Limited.

The report of the directors for the year ended December 31st, 1896, presented to the shareholders at the third ordinary general meeting of the company held at Winchester House, Old Broad Street, London, E.C., last Monday.

Capital.—The capital expended during the year at St. Luke's and Clerkenwell, and at Wandsworth, amounted to £159,954 2s. 6d., making the total expenditure on the two London stations up to December 31st last, £272,723 6s. 3d.

This expenditure has been met by the balance of instalments falling due on the first issue of 10,000 6 per cent. preference shares at par, and by a further issue of 10,000 6 per cent. preference shares at 20 per cent. premium, for which subscriptions amounting to over £400,000 were received.

The premium thus obtained has been applied as follows:—

To reduction of general preliminary expenses ...	£12,169	12	11
To writing off preliminary expenses in connection with St. Luke's and Clerkenwell	2,000	0	0
To writing off preliminary expenses in connection with Wandsworth	1,500	0	0
To writing off costs in connection with applications for provisional orders	830	7	1
Carried to reserve	3,500	0	0

Revenue.—The balance to credit of revenue account for the past year, after payment of proportion of rents, rates, taxes, and general establishment charges, amounts to £5,904 11s. 7d., to which is to be added £1,208 19s. 1d., being the balance remaining from last account after payment of the final dividend for 1895, making a total of £7,113 10s. 8d. available for distribution. Out of this sum an interim dividend for the half-year ended June 30th last, at the rate of 6 per cent. per annum on the preference shares, has been paid, and the directors recommend that a further dividend to December 31st, 1896, at the same rate, upon the preference capital, be declared. This will leave a balance of £525 12s. 9d. to be carried forward to next year's account.

St. Luke's and Clerkenwell.—In the St. Luke's and Clerkenwell districts the work on sub-stations and mains within the compulsory area was completed during the year, and additional mains have been laid down in other streets. Up to December 31st, applications representing 14,429 8-C.P. lamps have been received, and of these the equivalent of 14,179 lamps had been connected. Delivery of machinery into the station was commenced in October last; its erection is now far advanced, and by Midsummer, plant capable of supplying 60,000 8-C.P. lamps will be in working order. A considerable number of applications have been received for the supply of current for motive power; it is, therefore, proposed to lay down separate mains and continuous current machinery to meet the demand.

Wandsworth.—The station buildings are now completed for the reception of machinery; part of the plant has been installed, and the supply of current has been commenced. Applications for the equivalent of 3,509 8-C.P. lamps had been received prior to December 31st last.

St. Olave.—The provisional order granted to the company by the Board of Trade in 1895, was confirmed in the last session of Parliament.

Camberwell.—A provisional order for this, the largest parish in London, adjoining the parish of St. George the Martyr, for which the company also holds an order, was granted last year by the Board of Trade, and confirmed by Parliament. Our Wandsworth station will be capable of supplying all these districts for some time to come.

Other London Districts.—The company has applied to the Board of Trade for provisional orders for other London districts, and has received the consents of several of the local authorities concerned.

The Bournemouth and District Electric Supply Company, Limited.—Within the past year there has been a considerable increase in the consumption of current from this station, while a material saving in the cost of production has been effected. Further improvements in both these respects may confidently be expected in the present year. On December 31st last the equivalent of 23,267 8-C.P. lamps were connected to the mains.

The Dover Electricity Supply Company, Limited.—During the year just ended the applications had reached the equivalent of 7,808 8-C.P. lamps, of which 7,518 were then connected, and the current sold, including that for public lighting, amounted to 154,200 Board of Trade units. The best hotels and many of the principal shops throughout the town are being supplied, and a further considerable increase in lamp connections will take place during the present year. A contract for the supply of power to the Corporation for tramways has been entered into between the Dover Corporation and the company.

The Richmond (Surrey) Electric Light and Power Company, Limited.—In the year under review the connections at Richmond amounted to the equivalent of 7,125 8-C.P. lamps. As a result of the increased demand for current and of reductions effected in the cost of generation, the gross profit for 1896 amounts to £1,162 17s. 10d., as against £230 2s. 1d. in 1895. It is intended to further extend the area of supply in Richmond during the present year.

Mr. William Charles Braithwaite, having joined the Oxfordshire banking firm of Messrs. Gillett & Co., and finding himself too much occupied to attend the meetings of the company's board in London, the directors have, with much regret, to announce that he has resigned his seat on the board.

The retiring directors are Mr. Emile Garcke and Mr. Francis E. Savory, who are eligible for re-election. The auditor, Mr. R. H. Marsh, also retires, and is eligible for re-election.

The third ordinary general meeting of this company was held at Winchester House on Monday last, Lord Rathmore presiding.

The Chairman said that in 1895 their gross revenue amounted to £5,635, while last year it rose to £8,485, and the net profit in 1895 amounted to £2,714, while last year it was £5,904. A special satisfaction, he thought, might be drawn from this net increase, owing to the fact that a part of it—£1,145—was obtained from current actually supplied in their St. Luke's district. The item in the balance-sheet of "loans against security," amounting to £53,650, represented loans which had been advanced to the company on very favourable terms by their bankers. Sundry creditors and bills payable figured at £34,493. These two sums together amounted to £88,143, to meet which, on December 31st, £38,330 still remained to be received on calls on the second issue of preference shares which they made last year. This reduced the liabilities in question to £49,813, which must be further reduced by £8,620, the amount of the sundry debtors, which had since been realised. There had been a material reduction in the preliminary expenses, which now figured at only £11,409, as of the £20,000 received as premiums on the last issue of their preference shares £12,169 had been applied to reducing these expenses. Their investments in shares of subsidiary companies remained the same as in 1895, but the loans to those companies on mortgages, debentures, and bills had risen from £77,481 to £103,573. The larger portion of this amount was in relation to the Bournemouth and the Dover companies. These expenses had been unavoidable, but there was a good prospect of deriving an adequate return from these investments. The capital expenditure in those cases would in the future be but small, as they would be principally for extensions of mains and such additions to the plant in their generating stations as might be neces-

sary from time to time. Under the head of "pending applications for provisional orders," the amount now stood at £944, while the expenses incurred in connection with unsuccessful applications for provisional orders, amounting to £830, had been written off out of the premiums on shares. In the revenue account the item of directors' remuneration, salaries and wages, rent, rates and taxes, &c., was lower by about £440, while on the credit side the gross profits from "interest on investments, rents, discounts, and administration of associated companies" was £5,538 for 1896. They had had to suffer both at their Wandsworth station and their station at St. Luke's and Clerkenwell from considerable delay in connection with the strikes last year in the London building trade. At Wandsworth, the difficulty thus experienced was particularly aggravated, as they had to make large demands on the patience of their customers there who had been ready to take current from them. They were, however, met with great forbearance, and he was glad to say that this time of trial was now over. Since the beginning of January they had been supplying current in Putney, and from a later period they had been supplying current in Wandsworth and Streatham. At present they had applications for about 6,000 lights in the Wandsworth district, and half of that number had been attached to their mains, while the others would be attached as soon as the fittings of the houses were completed. He lived in the neighbourhood of Wandsworth, and he had very great confidence in the success of their station there. The building for their St. Luke's and Clerkenwell station was now almost entirely completed, and it was expected that by June they would have plant there capable of supplying 60,000 lights, and buildings which would be capable of accommodating plant to supply double that number. Moreover, whereas at present they had only the electric lighting to look to, it was confidently expected that they would derive income soon from the supply of motive power, for which they had already received a large number of applications from small manufacturers and traders. They had at present 16,000 lights connected to their mains in the St. Luke's district, and it was expected that the number by June next would be 20,000, and that by the end of the year this number would be more than doubled. Their indefatigable engineer, Mr. A. J. Lawson, also anticipated that within two years from now the whole of their present plant in the St. Luke's district would be taken up, while additional fields, in which they might hope to reap considerable profits, would be opened by extending their operations into their other North London areas. They held orders for several other large areas in London besides the Wandsworth and Putney and the St. Luke's areas. They hoped that for some years to come they would be able to supply current to their districts on the south side of the Thames from their Wandsworth station, and that on the north side of the river they would be able to make arrangements which would enable them for some years to come to supply their more easterly districts from their St. Luke's station. Other applications to the Board of Trade were also pending. He afterwards referred with satisfaction to the progress and the prospects of their stations at Bournemouth, Dover, and Richmond, and alluded with much gratification to a contract which they had entered into with the Corporation of Dover for supplying electrical current to the municipal tramways. The corporation guaranteed a *minimum* consumption of 160,000 units per annum, which was more than the company's total output for 1896, and this would be taken principally during daylight, when there was an easy load on their machinery for lighting purposes. They were now working steadily and rapidly forward, he thought, to that more mature stage in their existence when they would be able to pay dividends on their ordinary stock.

Mr. B. H. Van Tromp seconded the motion, which was carried unanimously, and a resolution was afterwards passed declaring a dividend of 6 per cent. on the preference shares.

British Blahnik Arc Light Company, Limited.

The statutory meeting of the British Blahnik Arc Light Company, Limited, was held at the offices of the company, 28, Victoria Street, Westminster, on Saturday, Mr. A. C. Schonberg, Assoc.M.Inst.C.E., in the chair.

The Chairman said: This company was registered on November 11th last, and we are in the pleasant position of having no more shares to allot, the whole of the capital, namely, £50,000, having been duly allotted. It was considered prudent to have at command a working capital sufficient to carry on our business with economy and safety. This sum your directors considered would be amply sufficient if represented by £10,000, and with that amount of working capital the company has accordingly started, and the whole of this is now at our bankers. This is a most satisfactory position, and that it has been successfully attained is a source of gratification, not only to the board, but we hope to you also. Our intention—at least at present—is to have our lamps manufactured either wholly or in sets of parts by reliable firms, and with this object in view we have been in constant communication with some of the leading firms in the country. We are pleased to say that several firms are making lamps for us, and here I may tell you that all the firms with whom we have discussed the lamp, as well as some of the greatest engineers, have, without exception, expressed delight and wonder at its principle, its simplicity, and reliability. This testimony, coming as it does from people experienced in arc lighting, as well as the best engineers, cannot we think, fail to be of the utmost satisfaction to you, and in regard to this I think I may say there is an extraordinary consensus of opinion as to the great merit of this lamp. We believe that in the Blahnik lamp you have a property which, with care and careful management, should prove to be a very remunerative and valuable one. The strides which have been made in electric arc lighting during the past few years are no doubt known to you; but always, more or less, in every lamp which has been put upon the market, something has been wanting, sometimes efficiency, sometimes steadiness, often reliability; and in the case of such lamps as have hitherto found some favour with the public, there has always been the one crucial question—cost. We are fortunate therefore in our start, and we begin with a policy which we think must lead to success. We have not been too anxious, and, indeed, we have not yet had time, to execute large orders; we have rather preferred, as it were, to feel our way. We are approaching every authority likely to require our lamps; railways, docks, harbours, the shipping interest, corporations, vestries, county councils, theatres, factories, hotels, &c., and in every instance we are seeing the right people, and in every case they have shown themselves more than anxious to give a trial to this wonderful lamp. As to the result of these trials, we have no doubt. As to the existence of a large demand for a cheap, reliable, and excellent lamp such as the Blahnik is, we feel assured. You will no doubt be interested to know that, so far as town lighting by electricity is concerned, there are in the present session of Parliament some 60 applications for electric lighting deposited by corporations, town councils, vestries, and other similar bodies, a number of applications greatly in excess of those deposited in any previous session within my knowledge. I think this fact goes far to prove what has been recognised very generally for some time, namely, that in this country we are now beginning to feel the effects of recent electric lighting legislation, both in the number of towns seeking powers for electric lighting, and also in the extensions required for those already in existence, the magnitude of many of these promising to exceed that of the original schemes. New railways are being constructed, docks and harbours are being extended, public buildings are being rapidly erected; in fact, in all directions there is every indication of a large and remunerative field for the business of this company. We are glad to be able to refer to the very cordial relations which exist between the French Company and this company. There is one important advantage possessed by the Blahnik lamp over any other lamp, namely, the power to increase or diminish the light. That will, without doubt, be of the greatest importance to railway companies, and more particularly for street lighting, as it renders an economy of current possible which does not exist in regard to any other arc lamp. There is one matter I wish to refer to, and that is the careful manner in which your interests have been, and I am sure will continue to be, safeguarded by your solicitors. We are on the threshold of what I hope is going to prove a very satisfactory, and for you a very remunerative business, and I am glad to be able to say that the directors are more than satisfied that however great may prove to be the ultimate success of our company, you will be largely indebted to your solicitors for the infinite care, the clear judgment, and the practical experience which we are so fortunate as to have at our command. In conclusion, I would desire to remind you of the fact that if in the Blahnik you have a lamp which is only as good as other lamps, you have, by reason of its simplicity and cheapness, an excellent lamp; but I should like to go a little further, and say that it is not only as good, but in many respects better, than other lamps, and I hope that when next we have the pleasure of meeting you, we shall have a good record of our stewardship to place before you.

A vote of thanks to the chairman closed the meeting.

Isle of Man Electric Tramway Company, Limited.

At the annual meeting on Monday, Mr. Bruce, the chairman, proposed the adoption of the report recommending a dividend equal to 8 per cent. for the whole year. The report was adopted. Mr. Bruce said an offer had been made to the Douglas Town Council to light the principal promenades and thoroughfares with electricity, on condition of being allowed to supply private consumers along the line of route, to run the cars on the bay section with electricity, and to construct the new quay section to the railway station, conceding 15 per cent. of the gross receipts from the quay line, and 5 per cent. of the receipts from the supply to private consumers to the Town Council. He disclaimed any intention of injuring the gas company, and said they intended to construct an electric line from Laxey to Ramsey, keeping the capital of the company distinct from that in existence, and working the line out of its own revenue.

Stock Exchange Notices.—Application has been made to the Stock Exchange Committee to appoint a special settling day in, and to grant a quotation to—Chicago Edison Company—$1,200,000 first mortgage 5 per cent. 30-year gold bonds.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending March 7th, 1897, were £1,062; week ending March 8th, 1896, £977; increase, £85; total receipts for half-year, 1897, £10,775; corresponding period, 1896, £9,987; increase, £988.

The Great Northern Telegraph Company. The receipts in February, 1897, amounted to £21,200; January 1st to February 28th, 1897, £42,400; corresponding month, 1896, £44,400; corresponding month 1895, £44,400.

The Liverpool Overhead Railway Company. The receipts for the week ending March 7th, 1897, amounted to £1,315; corresponding week last year, £1,040; increase, £275.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending March 5th, 1897, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £1,951.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, March 3rd.	Closing Quotation, March 10th.	Business done during week ended March 10th, 1897. Highest.	Lowest.
175,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	...	100 —104	100 —104	...	...
25,000	Amazon Telegraph, Limited, shares	10	...	...	...	6 — 7	4 — 5	4½	...
1,012,880£	Anglo-American Teleg., Ltd.	Stock	£2 2s.	£2 9s.	£2 13s.	51 — 54	51 — 54	51	...
2,993,560£	Do. do. 6 % Pref.	Stock	£4 4s.	£4 18s.	£5 6s.	95 — 96	95 — 96	96	95
2,993,560£	Do. do. Defd.	Stock	...	...	...	8⅛ — 8⅜	8 — 8⅛	8⅜	8
180,000	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	...	15¼ — 15⅝	15½ — 15⅝	15⅝	15¼
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	113 —117	113 —117	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	2½%	4 %	...	3¼ — 3⅜	3¼ — 3⅜	...	...
16,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	165 —170	165 —170	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	1½%	...	1/16 — 1/8	1/16 — 1/8	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8%	11 — 12 xd	11 — 20	11⅝	...
5,000	Do. 10 % Pref.	10	10 %	10 %	10%	19 — 20 xd	19 — 20	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	...	3¼ — 4½	3¼ — 4½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	10 — 10½	10 — 10½	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000	50	4½%	4½%	...	105 —108%	105 —108 %	...	...
60,710	Direct United States Cable, Ltd.	20	2 %	2½%	2½%	9 — 9½	9 — 9½	9⅝	9 1/16
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	...	17 — 17½	17 — 17½	17⅝	16⅞
70,000	Do. 6 % Cu.n. Pref.	10	6 %	6	...	18 — 19	18 — 19	18⅝	...
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	...	103 —105	103 —105	...	...
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	129 —132	127 —130	130	127½
250,000	Eastern Extension, Australasia and China Teleg., Ltd.	10	7 %	7 %	...	17½ — 18	17½ — 18	18	17⅝
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	...	100 —104	100 —104	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	...	101 —104	101 —104	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	...	128 —131	127 —130	...	...
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5%	100 —104	100 —104	...	...
107,600£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5%	101 —104	101 —104	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4%	107 —110	107 —110	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4%	110 —113 %	109 —112 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	...	11 — 11½	11 — 11½	11⅛	11
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	17½ — 17⅝	17 — 17½	17 9/16	17 3/16
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜%	10 %	...	24 — 25	24 — 25	24⅜	24⅛
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	102 —105 xd	102 —105	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	...	53 — 56	53 — 56	...	...
100,000£	London Platino-Brasilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6%	107 —110 xd	107 —110	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000	5	4 %	4 %	...	2 — 2½	2 — 2⅛	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 %	5½%	5½%	7 — 7¼xd	6⅞ — 7⅛	7⅛	6⅞
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18 xd	16 — 18	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	16 — 18 xd	16 — 18	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6½ — 6¾xd	6 — 6½	6 5/8	6 3/16
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	104 —107	102 —105	104¼	102⅜
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	4½%	5 %	...	11/16 — 13/16	⅞ — ¾	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4%	106 — 109	106 — 109	...	...
11,839	Reuter's Ltd.	8	nil	5 %	...	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	138 —143	138 —143	...	...
58,800	United River Plate Teleph., Ltd.	5	3 %	4 %	...	3¼ — 3⅜	3¼ — 3⅜	...	...
145,782£	Do. do. 5 % Debs.	Stock	5 %	5 %	...	100 —105	100 —105	...	...
15,509	West African Teleg., Ltd., 7,501 to 23,109	10	nil	4 %	...	5 — 6	5 — 6	...	...
238,200£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	101 —104 xd	101 —104	...	...
30,000	West Coast of America Teleg., Ltd.	10	nil	nil	...	¾ — 1¼	¾ 1¼	...	...
159,800£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	99 —105	99 - 105	101	...
54,248	Western and Brazilian Teleg., Ltd.	15	3 %	3 %	...	8¼ — 8⅜	8 — 8⅛	8 1/16	...
33,129	Do. do. do. 5 % Pref. Ord.	7½	5 %	5 %	...	6⅞ — 7¼	6¾ — 7	..	...
33,129	Do. do. do. Def. Ord.	7½	1 %	1 %	...	2¼ — 2⅜	2 — 2¼	2⅜	...
165,200£	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	...	114 —116	112 - 116	...	...
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	...	109 —113	109 —113	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅛%	⅛%	...	1⅛ — 1⅜	1 — 1⅛	1 1/16	1
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	11½ — 12	11¼ - 11⅜	11½	11¼
4,569	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	9⅛ — 10⅛	9⅛ — 10⅛	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800	100	5 %	5 %	...	107 —110	107 —110	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds	$1000	7 %	7 %	7%	107 —112	107 —112	...	...
164,800£	Do. do. 6 % Star. Bonds.	100	6 %	6 %	6%	100 —105 xd	100 105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	5 %	6 %	9⅜ — 10¼xd	10½ - 11½	10⅝	10⅜
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277	5	5 %	5 %	5 %	9 — 9⅜	9½ — 10	9⅞	9⅛
60,000	Do. do. do. 4½ % Deb. Stock Red.	Stock	...	4½%	4½%	112 —115	112 —115	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	5 %	7 %	18 — 19 xd	18½ — 19½	19⅜	18⅝
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16½ — 17½xd	16½ 17½	17 1/16	16 9/16
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	..	5 %	5 %	5 %	132 —136	132 —136	.	...
22,475	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—22,475	10	...	nil	nil	10⅜ — 11½	10⅜ - 11½	11½	11
20,000	Do. do. do. 6% Pref., 40,001—50,000	10	...	6 %	6 %	14⅜ — 15½	14⅜ — 15½	15 1/2	14⅜
10,000	Do. do. do. iss. at 2 pm., all paid	10	...	...		14½ — 14⅝	14½ 14⅝	14⅝	14⅜
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000	10	3 %	4 %	...	13½ — 14½	14½ — 15½	15½	14 7/16
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem.	10	...	...	...	10⅛ — 11	10½ — 11	10 15/16	10 13/16
150,000£	Do 4½% first mortgage debenture stock	...	4½%	4½%	...	120 —124	120 —124	...	..
5,452	Notting Hill Electric Lightg. Co., Ltd.	10	1 %	2 %	4 %	12 — 13	12 — 13	12⅝	12 7/16
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	6½%	7½%	10½%	13½ — 14½	14 — 15	15	14⅝
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 10	9 — 10	9 15/16	9⅝
50,000	Do. do. 4 % Deb. stock Red.	Stock	...	...	...	104 —107	104 —107	...	..
67,900	*Westminster Electric Supply Corp., Ord., 101 to 67,000	5	5 %	7 %	9 %	12½ — 13¼xd	12½ 13½	13⅜	12 17/16

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.

¶ Dividends marked ¶ are for year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation March 3rd.	Closing Quotation, March 10th.	Business done during week ended March 10th, 1897. Highest.	Lowest
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	2½%	...	...	⅞— 1⅛	⅝— ⅞	1⅛	⅝
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	...	...	1½— 1⅝	1½— 1⅝	1⅝	...
125,000	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	...	...	109 —112	107 —111	...	...
76,770	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	94 — 98	95 — 99	98¼	98
9,104	Central London Railway, Ord. Shares	10	...	...	...	9½— 10	9½— 10	...	...
207,649	Do. do. do. £6 paid	10	...	...	...	5¼— 5⅝	5¼— 5⅝	...	...
630,000	City and South London Railway	Stock	1½%	1⅝%	1 9/16%	59 — 61	59 — 61	60½	60
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	*nil*	...	1⅜— 2¼	1⅜— 2¼	1 5/16	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	5 %	5 %	...	1⅜— 2¼	1⅜— 2¼	...	...
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5 %	...	3 — 4	3 — 4	3½	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	4½%	4½%	...	105 —110	105 —110	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	5 %	...	1½— 1⅝	1½— 1⅝	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	2½— 3	2½— 3	2 5/16	2 3/16
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	...	...	⅞— 1⅛	⅞— 1⅛	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	...	...	⅞— ⅞	⅞— ⅞	...	...
9,600	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	10½%	...	11 — 12	11 — 12	...	
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	6 %	8 %	10 %	19½— 20½	19½— 20½	20	19⅞
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½— 19½	18½— 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	4½%	4½%	107 —112xd	107 —112	110	109
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	20½— 21½xd	20½— 21½	21⅛	20½
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	106 —109	106 —109	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	2⅞%	2½%	13 — 13⅛	12⅞— 13	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	16½ — 17	16½— 17	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	15 %	39 — 42	39 — 42	40	39¾
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	103 —106	103 —106	...	..
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £8 paid ...	10	...	...	...	10½ — 11	10⅝— 11¼	11¼	11

Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%; 1890—8%

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 9¼.
Electric Construction Corporation, 6 % Debentures, 103—106.
House-to-House Company (£5 paid), 5¾—6¼.
Do. do. 7 % Preference, of £5, 8¾—9¼ xd.
Do. do. 4½% Debentures of £100, 109—111.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 11—11½; 1st Preference Cumulative 6 %, £5 (fully paid), 8—8½. Dividend, 1896, on Ordinary Shares 7 %.
London Electric Supply Corporation, £5 Ordinary, 1½—1⅝.
Yorkshire House-to-House Electricity Company. £5 Ordinary Shares fully paid, 7—7½ xd. Dividend for 1896—7 %.

* From Birmingham Share List.

Bank rate of discount, 3 per cent. (February 4th, 1897).

INCANDESCENT LAMPS.

Mr. F. S. Terry read a paper on this subject recently before the Electrical Association at Milwaukee. The paper consists in the main of a repetition of a number of well recognised facts connected with the operation of incandescent lamps. Householders and consumers of electric lighting in general, who are familiar with technical terms such as candle power, volts, resistance, current, and the like, might read the paper with interest and profit, for the subject is discussed in a very clear, easily followed, manner. The information given is also very correct. Those, however, who are more conversant with electrical matters will come across nothing that is not self-evident, or that has not been often stated before.

The quality of lamps is shown to depend on defects either in the filament, the glass, the platinum, the cap, or to bad workmanship in any of the stages of construction. In the transformation of electrical energy by the incandescent lamp, 95 to 97 per cent. consists of heat, and only 3 to 5 per cent. of light; so that the real efficiency of a lamp is only from 3 to 5 per cent. The brighter the lamp is run the larger is the proportion of light obtained to that of heat. Lamps sold at 2½, 3, 3½, &c., watts per candle are simply ordinary lamps run at different degrees of incandescence; (and if this fact was only a little more understood by the public at large, they would not be duped into paying more for so called "lamps of greater economy"). The brighter lamps are run the more apparent become the defects to which they are subject. The resistance of the filament increases, the blackening of the bulb becomes deeper, the candle power drops, and the life is shortened. By the efficiency of a lamp is usually understood the initial efficiency. The real efficiency is the average efficiency throughout its useful life. A blackened lamp is an indication that it has been in use a good many hours, and it should not be complained of. A fluctuating voltage has a very detrimental effect on lamps and necessitates the use of lamps of lower efficiency than where a steady voltage is maintained. It has often been recommended to employ lamps of high efficiency so as to save current. But the figures showing the economy gained are exaggerated, for no allowance is made for the more rapid decline in candle-power that results. Lamps that have declined in candle-power more than 25 per cent. should be discarded. The practice of putting an old lamp in places where less light is required is not an economical one. The current saved by using a new lamp of small candle-power would more than pay its cost. Lamps that cost a little more than the average price affect very slightly the total cost of electric lighting. The average gross receipts of an illuminating company, which supplies both current and lamps, is about 26½ per cent. of the invested capital. Assuming that the lamps have an average life of 600 hours and cost 18 cents each, the cost for lamps will be about one-twentieth of the total cost of energy per annum. A difference of 1 per cent. in the cost of the lamps would come to about $\frac{1}{17}$th part of 1 per cent. of the investment in the year; or, to put it differently, it would take 17 years for 1 cent, added to the price of the lamps, to be equal to 1 per cent. of the capital stock. The quality of all lamps, however, is not the same. As a device for generating heat, where 95 or 96 per cent. is produced, different makes of lamps do not differ much from one another, but from the standpoint of light the difference between 4 per cent. and 5 per cent. amounts to 20 per cent. "If the customer pays three-quarters of 1 cent per lamp hour, and a lamp burns 600 hours, he pays for the energy consumed for that lamp during its life $4.50; and as light is the only product that is useful to the customer, a difference of 20 per cent. in the amount of light obtained from two different lamps would be a difference in value to the customer of 90 cents." In what way lamps differ from one another

by 20 per cent. in the light they produce is not very clearly indicated. Run at the same incandescence at the start, they all give practically the same proportion of light. Lamps of different make (and for that matter often of the same make), deteriorate unequally on running, and the sum total of the light emitted consequently varies. This is probably what is meant. The above quotation is from the American *Electrical Review* for February 17th, where a pretty full abstract of the paper will be found.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

DISCUSSION.

The discussion on Mr. Hollins's paper has shown that there is a considerable divergence of opinion on such questions as priority of invention, and as to which is the best system of electrical railway signalling. The discussion was none the less valuable on that account, and more especially since the leading experts in this subject took part in it.

The PRESIDENT stated that some time in the sixties he suggested to the London, Brighton and South Coast Railway a system of signalling with rail contacts.

Mr. WYLES, of the London and South Western Railway, considered that they stood first with the number of levers locked. At Waterloo they have a double system of signalling. About four years ago he introduced, along with Sykes, the locking of the starting signal. Their tablet system somewhat resembled the Webb and Thompson staff system, but Mr. Hollins's figure did not show that the lever must be put back before a tablet could be obtained. The Great Eastern Railway evidently had "train on" and "train accepted" signals, in addition to those used by the London and South Western. He doubted Mr. Hollins's statement that the lightning discharge was always positive; and even if it were, the currents induced by it would be of an opposite character. He knew of no instance in which a Sykes instrument had been discharged by lightning. The rail contact used on the L.S.W.R. is the ordinary Sykes treadle (fig. 15). He thought the mercury contacts were open to criticism, though the form shown appeared to be very good. They had found Sykes's selector to be a very good instrument.

Mr. LANGDON said that Mr. Hollins paper was of the greatest interest to railway engineers and the travelling public. Mr. Hollins was mistaken in thinking that this subject had not previously been brought under the notice of the Institution of Electrical Engineers, since papers read on this subject by Messrs. Preece, Mallock, and Siemens could be found in the proceedings. In reference to the question of who was the first inventor of electrical interlocking, he believed the system patented by Tyler, in 1869, was never carried out. In 1870 a patent was taken out by Mr. Preece and himself for a system of electrical interlocking, which was carried out in South Africa and at Wimbledon, and this, he believed, was the first that came into practical use. In 1868 he became connected with railways, and he thereafter produced a system of interlocking with the single needle block. His aim was to apply the system to existing instruments, since it saved the signalman the trouble of unlearning what he already knew, and picking up something entirely new. He considered that simplicity was one of the first requisites of a system of signalling. Mr. Langdon then explained, with the help of a diagram, his needle instrument. He used a rail contact on the Midland Railway before the introduction of the Siemens mercury contact; his contact was very similar to Mr. Hollins's treadle. In those days the engineers would not allow any tampering with the rails. He thought that sufficient deflection could not be obtained with the heavier rails now being introduced, to operate a Siemens mercury contact.

Colonel ADDISON, of the Board of Trade, said that there could be no doubt that wherever electrical interlocking had been introduced traffic had been expedited and safety increased. Such systems are by no means completely automatic; the signalman has still to work the signals. He considered that there was no force in the objection that such systems converted the signalman into a mere machine; nor in the objection that all these systems were incomplete, since it was much better to take a part till we got the whole. He thought, however, it was undesirable that so many different systems should be used by the various companies. Objections had also been made as to the reliability of the rail contact, but he thought that those who had used them did not, as a rule, condemn them. The results obtained by Mr. Hollins were very remarkable, and he should like to know whether they were obtained under ordinary conditions of working. He had recently seen on the Caledonian Railway a Sykes treadle with rubbing contacts, which promised to work well. He thought that a cancelling and releasing key should not be left in the hands of one signalman. He agreed with Mr. Langdon in regretting the limited extent to which the lock and block system had been adopted on the railways in this country.

Mr. SPAGNOLETTI could not agree with everything in Mr. Hollins's paper. Papers read before the Institution of Electrical Engineers should above all be accurate. Mr. Hollins had been guilty of the sin of omission; his description of other systems than the Sykes was too meagre, and of Spagnoletti's not quite correct. The Spagnoletti system was capable of doing all that the system commended by Mr. Hollins could do, and more. It protects standing trains, and has gone further than other systems. It uses one instrument for several lines, a circumstance which gives additional safety. Mr. Spagnoletti considered that if signalling systems were too automatic, it caused the intelligence of the signalmen to detriorate, and lulls them to a sense of false security. In 1873 he had brought out the rail treadle; he was the first to introduce them, and he had had no trouble with them. There were 360 treadles on the Metropolitan Railway, and the failures amounted to about one in a million. The treadle is useful for checking the signal at each end of the section, but he did not believe in many mechanical contrivances. In his system there was no connection between the electrical and mechanical appliances, but the second train could not be accepted till the signal had been put to danger. He considered the Sykes system was too mechanical and complicated.

Mr. W. H. WINTER showed the instruments at work which had been invented by his brother, and which were extensively used on the railways in India, the Argentine Republic, and in other places abroad. The instruments were of the needle type, and the system appeared to be exceedingly simple. In this system the signal cannot be lowered at A till B gives permission.

Mr. IRELAND, of the Great Northern Railway, said the Blakey and O'Donnell system was not merely on trial, as stated by Mr. Hollins, but had been adopted by the G.W.R. and approved by the Board of Trade. The system of signalling in tunnels was useful as well as interesting. The insulated rails have vulcanised fibre fish plates.

Mr. SHOOLBRED drew attention to Anderson's system of signalling, which was very little known. The inventor is now Sir W. Anderson, director of ordnance. He thought the perfect system of signalling would only be reached when large currents from central stations are available for working signals.

General WEBBER stated that he had examined a system of track circuit working on the Continent in 1867. The system of using large currents for signalling suggested by Mr. Shoolbred had been carried out by Siemens, the early days of railway signalling; it was used on a few railways, but soon dropped out of use.

Mr. WINTER supplemented the description of his brother's system by stating that it was a single wire system.

Mr. SPAGNOLETTI and Mr. MACMAHON gave some interesting statistics as to the working of the signals on the City and South London Electric Railway. It appears that there are about 8,500 movements per day, of which 4,500 are electrical. The number of failures in six months was only eight. All the treadles are worked by the last coach.

Mr. GOODENOUGH, of the G.W.R., sent a communication, which was read by Mr. Gray. He considered that finality had not yet been reached in electric interlocking. He considered that a line current was preferable to a relay; and he preferred the mercury rail contact, because it was less liable to fail on the wrong side. He thought that Hollins's electric tablet system was not quite perfect, since nothing prevented the driver leaving without the staff.

Mr. WEEKS said that a defect common to all the systems which had been discussed was, that there was nothing to prevent the driver over-running the signal. In electric railways this could be done by throwing out a section of the rail supplying the current.

Mr. HOLLINS, in reply, said: Mr. President: Since the proof of my paper was issued I have received a communication from Mr. Dunn, of the Caledonian Railway, pointing out that the description given of that company's electric interlocking is incomplete. It appears that the treadle which puts the controlling signal to danger behind the train as it enters the section does not release the plunger to enable another train to be accepted from the rear, but that the "train entering section" signal must be given to the box in advance and acknowledged before the lever, which is back-locked, can be put back to re-engage with the signal, and this lever being put fully back and re-locked, admits of another train being accepted. I much regret having misunderstood the verbal description given me by the manufacturer. I need hardly say I had no intention to under-rate the safety of the system, or to minimise the ingenuity of its designer.

Mr. Wyles pointed out that the arrangement of Mr. Tyer (fig. 6) for interlocking the signals with the tablet instrument did not compel the signalman to put his signal to danger. It was never intended to deal with that point at all, but only to show how it was proposed to unlock the signal by the act of obtaining a tablet. There are several ways by which this may be done. One is to automatically disconnect the battery whilst the signal is in the off position, and another is to mechanically lock the commutator of one or both instruments in whatever position it or they may stand so long as the signal is in the "off" position. With regard to the question of lightning, Mr. Wyles told us that he had never heard of it releasing Sykes's apparatus. Possibly not. Sykes's apparatus I think stands normally released on the L. and S.W. It is only locked whilst the train is in section. Does this suggest the reason to Mr. Wyles? I believe the failure is a very rare occurrence; but it was from Mr. De Malan, of the Hull and Barnsley Railway, that I heard of an occasional fault taking place, although, as he says, the signalman always knows what has happened, and raises the rod. The lightning therefore in these cases must have been "positive," or it would not have released the instrument. Mr. Wyles may be sure that I have not lost sight of the possible effect of the inductive discharge giving a current of opposite polarity, but I had some evidence, as he will now see, to warrant at least an experimental trial of a reversal of the coils and batteries. Mr. Wyles suggested that I had put forward the question of the back lock as peculiar to the Great Eastern Railway. I never made any statement to warrant such an inference. Mr. Wyles also questioned how I got at the figures given as to the working of the rail contacts. This information was obtained from a statement very kindly got out for me by our superintendent of the line (Mr. Nettleship), and therefore its accuracy is beyond question. This return shows that we have 78 boxes fitted with Sykes's apparatus; adding up the number of trains passing each box during the 24 hours, we find we have an average Sunday and week day of 31,556 trains signalled by

Sykes's apparatus during that time. We have 1,000 trains passing some of the signal boxes every day. On each occasion one at least (and in some cases three or four) of the rail contacts have had to electrically actuate or reset the locking apparatus. Multiply this 31,500 by the number of days, and you have the figures given by me. Mr. Langdon must pardon me pointing out that I did not claim that my paper was the first on block signalling. The papers referred to by Mr. Langdon (now some 24 years old) had but small reference to, and practically gave no details of, electric interlocking. As regards the similarity of the rail contact of Mr. Langdon and my own, I have very little doubt that if Mr. Langdon's arrangement had been a friction clutch, instead of, as it seems to me, in the nature of a ratchet, and the tail piece of the lever had been not only passing through the web of rail, but keyed into it (by a steel key piece) he would have had a similar result. The base or bedding on which to fix the rail contact is also a very important factor, and will have a considerable bearing upon the result. I was asked by Colonel Addison, with regard to my rail contact, if the results were obtained under the normal conditions of working. That is so.—under the normal conditions permanently in force. I was afraid that in giving the period covered as six months ending September 30th, and my reading the paper at the end of January would cause some doubt to arise whether a favourable period had not been selected, or a special result tried for in view of this paper. This was not so. The paper was written and sent in by me in October. Hence I mentioned the results of working during the latest period of six months at the time of writing. Since then we have had almost continuous wet weather, and yet I am pleased to say we have had even better results, for we had only two failures in the four months from September 30th to January 31st. There was not a single failure either in October or January, so that these 400 rail contacts have been actuated in the aggregate by nearly 4,000,000 trains with only two failures. It should be understood that all these failures are on the safe side, leaving the apparatus locked. I have not had a single instance during the last 12 months of a failure on the wrong side. Whoever is responsible for the maintenance of any complete system of electric interlocking on very busy lines where time keeping of the trains is held to be, next to safety, of the first importance, will soon realise that it is a very evident and a very heavy responsibility. It must be remembered that I am speaking now of sections over which there are from 500 to 1,000 trains per day passing. I determined from the first, therefore, to so divide the duties as to fix individual responsibility. The lineman in charge (with his assistant) whilst being really responsible for everything, is more directly responsible for the locking, the apparatus, and the wires. A batteryman is responsible for the batteries, and each section having from 65 to 100 rail contacts has a junior responsible for these. Each one has imperative orders that he must examine, clean, and if necessary, oil the parts as often as possible, the interval never to exceed 10 days or a fortnight. Steps are taken to ensure that this is done. Such are the arrangements in force (not more for one portion than another) in order to avoid delays to trains. But a better, more loyal, and energetic staff (and I am pleased to tell Colonel Addison that some of the best are from the Royal Engineers) no man could have. A special word of commendation being due to my untiring and energetic inspector, Mr. Sach, the son of my predecessor. With regard to the remarks of Colonel Addison as to the opinion which seems to be entertained in some quarters that treadles or rail contacts are unreliable and difficult to maintain, I should like to say a few words: I do not care what treadle or rail contact may be invented now, or at any future time, I am absolutely certain that if people think they are going to put them down and then leave them unexamined and uncleaned for an indefinite period in the expectation that they will not fail, they are foredoomed to disappointment; in fact they deserve to fail. I have tried all kinds of contacts, and I have had two attached to the rails the same as the Siemens and the Sykes contacts for over two years, and they have been carefully watched. I am sure I have not sought to make any invidious comparisons, for I am quite certain that the Sykes treadle (and I dare say Siemens and Mr. Spagnoletti's also) are most reliable treadles. But whilst attachment to the rail is excellent in principle (and you must keep the contact firmly in approximately the same position in relation to the rail), still it will not, without care and attention, avoid failure. The very necessity of the principle brings in another factor necessitating attention. You must have bolts and nuts, or some similar device, to attach the support to the rail. Every railway man knows how nuts work loose on the bolts securing the fish plates, and necessitate constant attention by the platelayers to keep them tight up. You may put on your locking nuts and your cotters, the shake and the rattle, and the vibration with 50 to 60 ton engines thundering over them will upset those little devices—there is nothing for it but to attend to them and keep the nuts tightened up. If this is not done it is not giving the contact a chance, as it will inevitably fail, however perfect it may otherwise be. And here, let me say, I lay no claim to originality as regards the friction clutch. That was patented by David Rossman, of New York City, over 20 years ago. Whatever little merit may attach to mine is in the method of applying it. As regards Colonel Addison's remarks with reference to the control of the cancelling key or switch. It has not yet been tried in actual practice on the line, but to show its practicability it was fitted to the model installation which was in the room when the paper was read. I hope, however, to soon get an opportunity of giving it a trial in actual practice.

And I now come to the remarks of my friend and colleague, Mr. Spagnoletti: He pressed so many invidious comparisons upon our notice as between his own system of electric interlocking and that for which I am responsible, that unless I agree to stultify myself, as it were, by silent acquiescence, I must undertake the disagreeable duty of controverting. The very comparisons made invite, I will not say retort, but defence. In the first place he complained because in my paper I have had the temerity to give, as he puts it, undue prominence to one system; that is, because I fully described that which I know all about, and left, so far as details are concerned, my friend to do that full justice to his own which he could do so much better than me. I wish he had done that and left those comparisons out. But first as to this complaint of my giving only a meagre description of his apparatus. Has he forgotten that I asked him to let me have the instruments and take drawings and descriptions, or to favour me himself with a detailed description? I had to take notes and write the description from memory of the verbal explanation given me. How can he complain now when he deprecated my giving any full description, and advised me to deal with the subject briefly. Surely he did not expect that in taking his kindly advice about his own system I must necessarily do the same with others? I noticed Mr. Spagnoletti seemed to make a very broad claim to the rail contact for electric locking, and to take it as a compliment to himself that others now use them. Every railway man acknowledges how much Mr. Spagnoletti has done in block signalling and electric locking, but surely he knows that electric rail contacts were devised and used for signalling purposes many years prior to 1873. As I mentioned in my paper, Mr. Edward Tyer had one in January, 1852, for train signalling (and in use), but in November, 1852 (the same year), a Mr. J. S Crowley proposed to use a treadle or rail contact for electrically putting the signal to danger behind a train, and for the levers to be also actuated by it, or released so that an attendant could actuate them. In fact, there are many instances prior to 1873. And now with regard to the traffic on the Metropolitan Railway (not the District), Mr. Spagnoletti said "they have got somewhere about 6 or 8 million trains in a half-year running over that line." I should like to know if Mr. Spagnoletti still maintains those figures, because I have been in search of those 8 million trains ever since our last meeting. And then as to tunnels. Mr. Spagnoletti speaks of the *dis*advantages of having the treadles or rail contacts in tunnels—should not *dis* be crossed out and the word read as "advantages." No doubt it is inconvenient to get about after the rail contacts in the dark tunnels; but then there is the advantage in other respects, and that is the absence of the effects of the heavy rains and the frost and the snow on the ballast, which is such a fruitful cause on open lines of the road giving and the rails settling down. I have only four rail contacts in tunnels, and these do not, on an average, fail once in 12 months. Mr. Spagnoletti, in referring to his lock being on the trigger or catch rod of the lever, represented me as saying in regard to this that I considered the lock should preferably be on the lever. This is really too bad. I simply stated where the lock was fitted. I never expressed any opinion about it at all, and I refrain now. With regard to his statement as to what may take place with the lock on the lever if a man puts his whole strength or weight on it. I may be sensible of the weight of Mr. Spagnoletti's arguments, but I challenge him, or any one else, with all their strength and weight, in any fair manner to either damage the machinery or bend it, or slip it out of the slot. Mr. Spagnoletti states that with Sykes's system the locking instrument must be placed over the lever. But this is not so. As a matter of fact, sometimes the instrument (say, at central junction, Stratford), is placed over one lever it is true, but is perhaps locking several other levers 20 or 30 feet away, as it is not necessary with the Sykes's system to have a separate locking instrument with electro-magnet for each lever. Again, Mr. Spagnoletti represents me as saying that I thought the lock indicator showing lock "off" and lock "on" should be in the line. I said nothing of the kind. I said the *block* (not the lock) indication "Line clear" and "Line blocked" should be given by a coil in the line circuit. I hope he will pardon me for the presumption, but personally I think his lock indication might be better given mechanically and directly than electrically. His lock is at the back of each lever, and what more proper place for the indication. And now as to my reason for the block indication being given by a coil in the line. In the first place what does our combined apparatus purport to be? Why, apparatus for electrically interlocking the block with the mechanical signals. Not abolishing the one because you are locking the other. I have always strongly urged, and I do so most strenuously now, that the signalmen should not work merely and solely by the lock indications. They should work strictly to the block, and leave the lock what it is primarily intended to be, a check upon the use of the lever of the corresponding outdoor signal until the block instrument, by giving the state of the section, indicates that the section is right for it to be used. The lock indications are merely to show if the lever *can* be used. In any system I think that this principle of working is of the highest importance. Another reason is (if Mr. Spagnoletti will pardon the suggestion) that having once given the "line clear" indication by unlocking the lever, the man in advance is deprived of the means of again blocking the line in case of emergency. Again, the signalman in the rear has really no indication of the state of the section in advance. It is the position of his own lock alone. What therefore would be the effect of a contact from other wires charged with a current strong enough to discharge the lock? Why "line clear" and the lever free, and nothing to tell him it was the result of a contact. However, I refrain from giving further reasons, and let me here add that I should be sorry if these invited criticisms should cause anyone who may agree with me to take them as an objection to Mr. Spagnoletti's system of electric interlocking. It is an important point in my opinion, but it is simply corrected by placing in the line one of his admirable coils (for which all railway men have to thank Mr. Spagnoletti), with the induced undemagnetisable needle.

With regard to Mr. Goodenough's communication. I think he misunderstands what I said in my paper. I daresay I have not been as clear as I might have been. He states that as regards interlocking the tablet and train staff instruments on single lines with the starting signals that the arrangement seems wanting, as there is nothing to ensure that the train shall arrive at the other end before the signal lock can be again released. Every one of the conditions Mr. Good-

enough lays down as essential is complied with in the arrangements I describe. Indeed, *without* one part, namely, the treadle. That is not necessary, because the tablet or staff must arrive at the other end before either a signal at either end can again be lowered or another tablet or staff obtained. You cannot get a signal without getting a tablet or staff, and as you can only get one of them at a time you can only get one signal. The signal must be put to danger, or you will not get another tablet or staff, and once to danger it is locked.

I think the suggestion of General Webber and Mr. Shoolbred that there might be something to be learnt by looking back and examining some of the arrangements and devices proposed and in use to some extent many years ago for signalling trains well worth consideration. Long before the time of signal boxes, lever frames, and block telegraphs had been seriously thought of, all kinds and descriptions of automatic signalling arrangements were proposed, and very ingenious many of them were.

Mr. Weeks caused some amusement by remarking that we had heard of nothing yet to stop the engine drivers from over-running the signals. Why even something better than this was proposed by De Castro in 1853. He proposed by means of electricity that should two engines of different trains get within a certain distance on the same line of rails an alarm should be sounded on both engines, steam shut off on the second engine, and the brakes put on. In fact, having by me all the abridgments of electrical patents from the earliest periods, I have been extracting from them in my leisure hours a few notes in chronological order of those old inventions relating to railways. They are very interesting; they induce a feeling of very considerable respect for the work of those who have trod the path before us, and a corresponding humility of spirit in estimating the value of our own. Some day I may ask my railway friends to accept a copy of these notes. It has been said that it is very undesirable to alter existing systems of block, necessitating the signalmen being taught an entirely new system of working, and also that it is absurd to suppose that railway companies will scrap all their present block instruments. This looks a formidable argument; but in my opinion too much is made of it. It seems to me that to tack on to existing block instruments the necessary additional parts, such as a special electric lock for each lever, switches, relays, &c., for each block instrument will cost just as much if not a little more than to provide the entirely new combined electric lock and block instrument made for the purpose. If anyone will go deeply into the question as I have been compelled to do, they will find it as I say. Then as to the altered system of working, we have entirely changed our system of working from Tyer's one wire to Sykes's three-wire on our suburban lines in some 78 boxes. We have not found the least difficulty in this, and I am not aware of a single instance of mistake in working, notwithstanding our heavy traffic through changing from one system to the other. Of course, each section is changed over box by box, carefully ensuring that all is working easily and smoothly at one box before another is brought into use. We never had the slightest hitch. There is the further consideration of simplicity in working, and that is particularly important on busy lines. I know that on the Great Eastern Railway, when it was under consideration to adopt the single needle block, it was found absolutely impossible to adapt it with its code of signals as in use on other railways to the requirements of our heavy suburban traffic. We could not have got our traffic through. In signalling trains there are a certain definite number of bell and plunger (or in the single needle block) needle, movements required to be transmitted by the signalmen for each train. I give a few of the code requirements:—

Tyer's double line block	...	...	...	19 movements.
North-Eastern S. N. block	...	...	...	30 "
Great Northern S. N. block	...	...	...	32 "
Midland S. N. block	...	...	...	44 "
Sykes's lock and block (G. E. form)			...	11 "

It will thus be seen how important the question is—so simply and so rapidly can the Sykes's system be worked, that we have boxes manned by one man where there are six lines of rails, with two or three sidings connections, and about 1,000 trains per day passing. I say distinctly, that with the single needle block for instance, with any of the codes named, this working would be absolutely impossible.

The Northern Society of Electrical Engineers.

Methods of Charging for Electricity Supply. By R. P. Wilson, member. Read Monday, March 8th, 1897.

This subject has recently received some considerable attention at the hands of central station engineers, both in this country and on the Continent, and several more or less successful attempts have been made to arrive at and substitute for the primitive method of giving discounts in proportion only to the number of units consumed, a system which is equitable to the consumers generally and remunerative to the "undertakers."

The following systems are at present in use:—

1. Discount based on the number of units consumed.
2. Discount based on the number of units consumed per lamp installed.
3. "Daylight" circuits at reduced rates.
4. Motive power and cooking at reduced rates.
5. Wright's maximum demand method.
6. Andrews's modification, as used at Hastings.
7. The sliding scale, adopted at Ayr.
8. Differential rates, based on time of demand, as at Norwich.
9. Differential rates, based on time of demand, as at Bristol.

In this paper it has not been considered necessary to attempt to convince those who do not admit the shortcomings of the first of these systems, and the author contends that Dr. Hopkinson's statement of the case is fundamentally correct—that it is a statement of facts, not an expression of opinion.

The first of these systems was adopted by several of the London stations and continues to exist, because the agreement entered into between undertakers whose areas of supply overlap, and who are consequently in competition with each other, has not yet terminated. The Westminster Company still maintain that this system is right.

Before considering the merits of any system, it will be well to emphasise the fact that the ultimate objects of any system are:

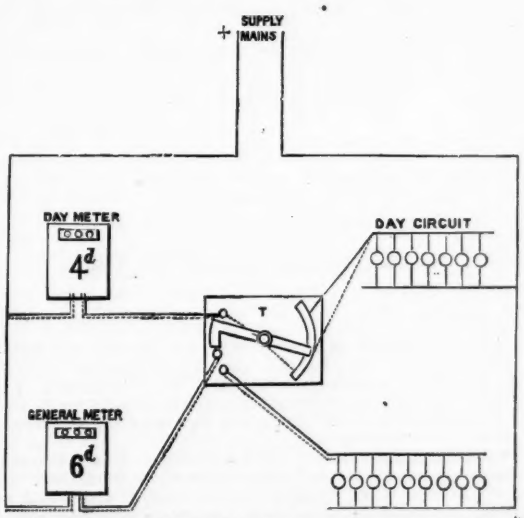
1. To popularise the use of electrical energy.
2. To reduce the cost of production.
3. To enable electricity to compete favourably with gas.
4. To provide an equitable basis of charging.

These objects can only be achieved by increasing the output of the plant, or, as Dr. Hopkinson expressed it, the rate of output; it therefore follows that the first step must necessarily be to ascertain the existing rate of production, and the second to improve it by encouraging or subsidising those consumers who are profitable, and by pointing out the error of their ways to those who are not profitable.

The first system, or lack of system, does not fulfil any of these conditions, and the only purpose it serves is to prove Dr. Hopkinson's theory, which it does conclusively by the familiar method known as "reductio ad absurdum."

The second scheme which, as far as the author is aware, was devised by Dr. Hopkinson with a view to satisfying his conditions to some extent, is a considerable advance in the desired direction; the objection to it is a fatal one, and consists in the fact that it discourages the use of lamps anywhere, except where they are burnt for long hours, or where they may be considered a necessity; thus a consumer has no inducement to use electric light throughout his premises, although there are many positions where lamps burnt only an hour a day may be most profitable to the station, but if the consumer's discount varies inversely with the lamps installed he naturally restricts their number.

We now come to the "Daylight" circuit. This system is in use at the Kensington Court Station of the Kensington and Knightsbridge Company, and elsewhere, but is by no means satisfactory to the consumer. The principle on which this method is based is that a reduced charge should be made during hours of daylight. Two meters are provided and connected to the circuits, as shown in fig. 1, in such a way that the turning on of any one lamp on the control circuit brings the high rate meter into operation and cut out the other.



T, two-way switch; one single and two double contacts, the latter bridged by bar of switch when the general lighting is in use to be fixed in a box that can be sealed, handle of switch only projecting.

Fig. 1.

This method involves enormous expense in wiring the premises, inasmuch as two distinct circuits are necessary. It is, as far as the author is aware, only used in shops. The shopkeepers find it very inconvenient, because the cost of rearranging the circuits makes it impossible to materially alter the distribution of the articles to be displayed.

In cases where all three wires of a three-wire system are brought into the house no less than four meters are required, and the distributing board must be provided with five bus bars as well as the specially-constructed switches for the control circuit. See fig. 2.

The author will be glad to hear anything that can be said in support of this method, which appears to him crude and complicated.

The complications necessary to carry out this system in a 5-wire circuit are too appalling to contemplate.

The fourth system provides for the consumption of power in motors and cooking utensils at reduced rates.

Here, again, at least two distinct circuits and meters are required; but the possible, and, in fact, inevitable overlapping of the consump-

tion in the power and lighting circuits, is ignored, and it is quite conceivable that a consumer using power without restriction would be comparatively unprofitable.

This system is a very small modification of the reduction on taking a quantity method, and is, indeed, not as comprehensive unless worked in conjunction with it, as consumers of light alone derive no benefit from it. It is quite as important to popularise the use of electricity for light as it is for motive power, for the reason that by far the majority of a central station's existing consumers do not, and never will, use motors, even if they can be induced to cook by electricity.

"Wright's Maximum Demand Method." The details of this system are so well known, and are so clearly set forth in Mr. Wright's paper, read before the Municipal Electrical Association of June 11th last, that it would be superfluous to describe them here.

Last time the author had the pleasure of addressing this Society, he strongly advocated the use of the maximum demand indicator, and is given to understand that it has been very largely adopted, with eminently satisfactory results in every case.

It is unfortunately impossible to devise a system that shall be in all respects perfect, and the results obtained at Brighton tend to show that Wright's method leaves very little to be desired; it has, however, one small defect apart from its complication and expense, viz., that the spirit of the method has to be departed from because the indicated demands are not all simultaneous; as a matter of fact, the sum of the demand indicator readings is 50 per cent. more than the actual maximum demand as represented by the actual output of the station at Brighton. And although, in making out the accounts, this discrepancy is taken into consideration, all the consumers do not benefit in the proper proportion.

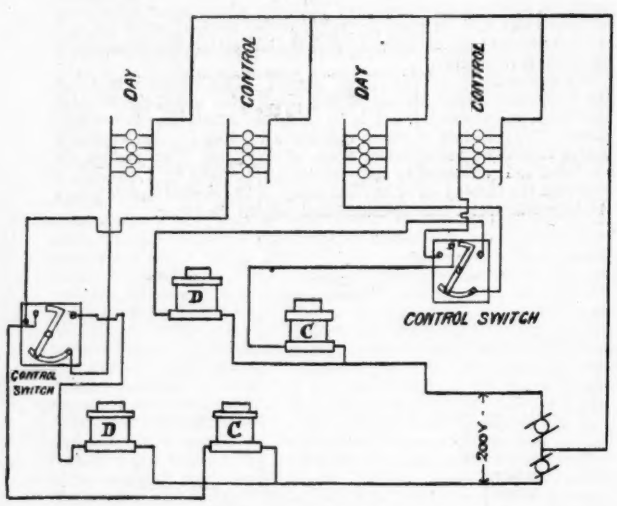


Fig. 2.—Daylight System on the 3-Wire Circuit.

Mr. Andrews, at Hastings, has, with a view to avoiding the apparent complications of the demand indicator, devised and put in practice a method of charging which takes Wright's formula as a basis; but instead of so much per unit of maximum demand for the first hour, he charges 1s. per 8-C.P. lamps used simultaneously per quarter, and 6d. per unit consumed.

This arrangement produces a tendency to turn on as few lamps simultaneously as possible, and thus attains the end in view; but there is some force in Mr. Wright's criticism, that it would tend to reduce the number of lights installed, because the consumer argues that, by reducing the number of lamps installed, he reduces the number that can be turned on simultaneously.

Mr. Andrews has not found this effect at Hastings, and there is no doubt that his charge is much simpler to explain to the consumer than Wright's. The average layman cannot grasp the subtleties of a charge based on the maximum demand, and this, after all, is not surprising, when we consider how many years it has taken central station engineers to realise its advantages. At Blackburn the consumers are agitating because they do not understand the system and therefore fail to realise on what ground the tramway company should pay only 2d. per unit.

It has been contended that there is only one Brighton, and that the magnificent results obtained by the maximum demand system at Brighton would not be realised anywhere else. Brighton may have peculiarities; it is in fact unique in that there is only one Mr. Arthur Wright, but that the conditions of electricity supply are materially different to those that obtain in general is not supported by any evidence; on the contrary, the demand indicator produces the same results wherever it is adopted, whence it follows that the virtue lies in the system, not in the site.

Mr. Hordern presumably contends that no system would have the effect of inducing consumers to extend their lighting, or to use power more effectually, than his sliding scale of discounts. The word *his* has been used advisedly, because he has made the system so entirely his own, in that he appears to be its only champion, but the results actually obtained, wherever a differential charge is made, show that this contention is not justifiable.

In the Westminster area there are an enormous number of residential flats, and in the majority of cases electric light is not used in passages, staircases, and basements, and in some cases the hall porter turns out the electric light and lights the gas every night at 9.0 p.m., and thus the supply company deprives itself of a large number of the most profitable lamps in the district.

Another drawback to the use of the maximum demand method is that an abnormal maximum may be indicated if more than the usual number of lights is used simultaneously for any one evening during the quarter; and to obviate excessive charges arising from this cause, consumers are advised that they will have the privilege of paying only for the light they consume on such occasions if they will previously advise the undertakers.

This is no doubt satisfactory to the consumer (if he remembers to give notice), but it must be borne in mind that if his normal maximum demand is allowed to stand as the basis of his bill, he not only creates an objectionable rise in the peak of the load curve, but gets a larger number of units at a discount than a more profitable consumer.

Many sliding scales have been devised and tried, with more or less satisfactory results. Mr. Ernest G. Pink adopted a system at Ayr, which consisted in giving discounts to the various consumers based on the duration of their demand, or in the case of shops on the hour of closing. Shops closing at 7 p.m. get no discount. Public houses, restaurants, &c., closing at 10 p.m., 22½ per cent. Private houses, 35 per cent.

This system apparently worked very well at Ayr, and in other places where it has been used, but the complication in the accounts due to giving one or more different discounts to every consumer militates against its adoption even in small towns. One of the consumers at Ayr, who applied for a discount on the ground that he burnt lights in dark corners for very long hours, received no encouragement, although he was probably the most profitable consumer connected, on the ground that the undertakers were "*not responsible for structural difficulties.*"

We now come to what, in the author's opinion, is by far the most satisfactory principle, namely, the differential rates based on the time of day, as compared with the period and the area of the load curve peak. The essential difference between this principle and Wright's is that, whereas his charges are based on individual demands, the time rates are based on the actual output of the station as a whole. If, as has been generally admitted, it is equitable to grant discounts to the most profitable consumers, it follows that those who contribute least to the peak should benefit most largely by the system of discounts.

It is quite reasonable that all consumers should pay some proportion of the standing charges, but it is not reasonable to charge an early morning consumer whose demand is 10 amperes the same proportion as one whose 10 amperes is demanded during the heavy load.

Mr. Gisbert Kapp was the first who took this into consideration, and he patented what may be called a "time-switch," whose duty it was to automatically control the registration of the meter in such a way that all the current consumed up to a certain hour should be charged at a reduced rate, and all the current consumed during the hours of heavy load should be charged at full price. This method has the unquestionable merit of simplicity, and the author has so far been unable to learn any sound objection to it as a principle.

Mr. Kapp's time switches are used at Bristol, but only to a limited extent, that is to say, in the premises of only a few consumers who have, or appear to have, special claims on the consideration of the undertakers as being exceptionally profitable consumers, but it is difficult to understand how one unit supplied at 10 a.m. can be more profitable than another.

(*To be continued.*)

The Société Internationale des Electriciens.

The Higher School of Electricity.*

The Administrative Committee of the Société Internationale des Electriciens decided, at the sitting of November 25th, to separate the administration of the Central Electrical Laboratory from that of the Higher School of Electricity, which had been added to the former in November, 1894. This separation was rendered necessary by the different sources of the funds provided for the expenses of the two establishments.

The Laboratory budget in fact, at present, is made up, both as regards receipts and expenses, of sums that may be looked upon as fixed.

The School expenses, which vary with the extension of its objects, are met by special subscriptions, and by the fees of the students, and the admission payments for the lectures that are open to the public.

The Committee thought, moreover, that it would be expedient to separate the Councils of the two Institutions, and to interest donors more specially in the progress of the Higher School of Electricity. The following regulations have therefore been drawn up, to be in force on and after January 1st, 1897.

Administrative Regulations.

Art. 1.—The budget of the Higher School of Electricity is made up:—

1. By the subscriptions collected for the maintenance and development of the school.

2. By the fees of the students and the payments of the public.

* At the sitting of December 30th, 1896, the Administrative Committee decided that the School of Application should in future be designated as The Higher School of Electricity.

Art. 2.—A Council for the Improvement of the School has been appointed, which will comprise:—

1. The President of the Administrative Committee of the Laboratory, President.
2. The President in office, the President appointed for the following season, and the General Secretary of the Société Internationale des Electriciens.
3. Three members of the Société des Electriciens, elected for a period of three years by the Committee of Administration of the Society.
4. The Director of the Central School of Arts and Manufactures.*
5. The founders.†
6. Those persons who give their support to the School by regular conferences.
7. The Director of the School.

Art. 3.—The Council of Improvement assembles when convoked by the President, and at least twice a year. It determines the conditions of admission, the programme of the instruction and the work of the school.

It decides all questions relating to the appointment and the salaries of the professors and the staff.

It decides at the end of the season what is to be done with any available surplus funds, subsequently rendering an account of the same to the Committee of Administration of the Société Internationale des Electriciens.

It authorises, within the limits of the funds available for the purpose, all necessary improvements in the installations or plant of the school.

It submits to the Committee of Administration proposals for extra expenses, for which a supplementary fund would be necessary.

It prepares annually the school budget, and submits it to the approval of the Committee of Administration.

Art. 4.—The Council of Improvement shall have the power to propose to the Committee of Administration of the Société Internationale des Electriciens any modifications in the present regulations that experience shall show to be advisable.

Central Electrical Laboratory.—The position of director of researches in the measurement department at the Central Electrical Laboratory is now vacant. Candidates are invited to send the applications, stating their qualifications, to the Director of the Laboratory, 14, Rue de Stael, Paris.—*L'Industrie Electrique.*

OFFICIAL VOCABULARY FOR CODE TELEGRAMS.

A NOTICE under the above heading appears in the *London Gazette* of February 23rd, 1897. It refers back to and quotes a notice which appeared in the same paper on January 12th, 1894, and concludes thus:—

"As there appears to be a certain amount of misapprehension on some points arising out of the request that codes, or collections of code words, may be submitted to the Bureau, the Postmaster-General thinks it right to call attention to the following points:—

"1. It is unecessary to send to the Bureau copies of codes which have been compiled from the present edition of the 'Official Vocabulary,' as all the words in that work, with the exception of a few incorrect expressions, will be incorporated in the new edition.

"2. It is unnecessary to send to the Bureau individual copies of published codes, or of codes compiled from published collections of code words, if the compilers or proprietors of those published codes or collections of code words have themselves forwarded the works in question to the Bureau.

"3. The Bureau is not concerned to know the meanings attached to code words, and it is quite sufficient for the purpose in view if a list of the words comprised in each code be forwarded.

"4. The Postmaster-General will, if desired, communicate with proprietors or publishers of codes, in order to ascertain whether they have taken step to ensure the continued validity of legitimate words in their codes by complying with the request of the Bureau.

"5. The Postmaster-General will, if desired, forward to the Bureau codes or collections of code words sent to him with that object."

It does not seem to be quite understood by the Postmaster-General (par. 2) that the proprietors of codes cannot send to the Bureau more words than they have at present in use and available, and that these within a month may be used up, and it would be necessary to add others from a collection of their own choice. Pars. 4 and 5 point to a tardy concession as to the expense of transmitting codes to the Bureau.

One way or another, we think the Postmaster-General and the Bureau are perilously near asking code makers and others to bring figures into general use as a code for telegrams. With the 5-figure limit this would create a state of things which could not be looked upon with equanimity by any telegraph enterprise.

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* By the decision of the Minister of Commerce, the Central School has been authorised to pay the expenses of instruction of a certain number of pupils, who shall pass the leaving examinations, and who are desirous of completing their studies, from an electrical point of view, by attending the lectures at the Higher School of Electricity.

† By founders are meant either societies or administrations that contribute to the maintenance and development of the School by an annual subscription of 1,000fr. or by a donation of 10,000fr. These administrations or societies are represented at the Council of Improvement by a delegate.

LEGAL.

HOOKHAM *v.* JOHNSON.

(*Concluded from page* 312.)

Mr. BOUSFIELD, in opening the defendants' case, said that the type of action they were trying differed altogether from the ordinary type of patent actions. The type of action with which they were familiar was when some gentleman came forward having what was called a "pioneer" invention—where it was known that prior to that date nothing of the sort existed, and so on. Ayrton & Perry had invented a particular type of meter which was successful, the theory of which had been clearly expounded by them, and the necessary directions given to enable that to be carried out. To an electrician, the thing was absolutely clear. He should call evidence to show that anyone who took the specification of Ayrton & Perry, and put it into metal, only one difficulty would arise, and that would be the friction of the commutator. That did present a great difficulty, and that difficulty was overcome by Elihu Thomson, who took and worked upon that very form which was clearly described in Ayrton and Perry's specification. He thought that he would use silver instead of copper for his commutator and brushes, and by that he got a motor the friction of which was so small that it did not seriously interfere with the accuracy of the meter. So he got over that, and made the Ayrton & Perry meter in the very simplest form. There was nothing of invention about it; he took a machine of very well known type, and it was made according to the specification of Ayrton and Perry. Everybody in the electrical world gave to Ayrton and Perry the credit of that particular type of meter.

His LORDSHIP: What strikes one is that it took seven years to bring it to a practical thing. It is an argument, of course, which could be used on the other side.

The LEARNED COUNSEL, continuing his address, said that not one of the plaintiffs' witnesses spoke of any difficulty presenting itself in making a practical meter, except the difficulty as to the commutator. He should put it to his Lordship that the defendants had borrowed nothing from Mr. Hookham to enable them to construct their meter. Who had solved the question of the commutator? Not Mr. Hookham. Mr. Hookham, it was true, had invented a form of motor which might have done relatively good work, and he had sold a certain number, but it was not a form which had survived. That did not help the defendants to their solution. It was the Edison invention of 1883 which solved the difficulty of the motor and commutator. That that showed the complete solution of the matter was not questioned. Both Prof. Perry and the plaintiffs had adopted the ideas in Edison's specification. Mr. Hookham had thrown aside his own device for getting over the difficulty of the commutator, and had adopted Edison's motor, the defendants doing likewise. Mr. Hookham's solution of the difficulty had been of no service to the defendants, or of any permanent service to himself. He submitted that it must be obvious to his Lordship that the motor part of the defendants' meter—the Edison cup—was not the motor which was described in the drawings of plaintiffs' specification, and nobody could suppose that it was.

Professor PERRY, examined, said that he was Professor of Mechanics and Mathematics to the Royal College of Science, a fellow of the Royal Society, a Doctor of Science, Vice-President of the Physical Society, and Vice-President of the Institution of Electrical Engineers. The meters complained of were made by the defendants, who were licensees of his. Professor Ayrton and he, in 1882, had had a good deal of experience together in electrical meters, and they made a great variety of measuring instruments and current meters. They were making all the measuring instruments, practically, which were used by practical people. They were practical electricians, and not merely theoretical professors. The meter in question was intended to be an energy, or quantity, meter—or current meter, as it was called. In his opinion the elements which were necessary for the apparatus to be an effective current or energy meter were properly set out in the specification. In that specification he and Professor Ayrton pointed out two classes of energy meters, one being driven by a motor and the other being a clock meter. Both of those classes of meter came into use. At the Paris Exhibition, in 1889, the only meters which received the prize were the Aron meter, which was acknowledged to be theirs (Ayrton and Perry's), and the Elihu Thomson clock meter, the specimen of which, in Court, was given to Professor Ayrton, with a statement that it was the Ayrton and Perry meter.

The Court then adjourned.

Prof. PERRY'S examination was resumed on Wednesday. He stated, in answer to Mr. GRAHAM, that in 1889 he invented the Hookham commutator——

Mr. MOULTON objected.

Mr. GRAHAM: I am only asking these questions to show that he designed the whole thing.

WITNESS, continuing, said that in 1883 Edison had tried to solve the problem, and had designed a meter, which had no armature.

What was the fault of the Edison meter?—It had a quasi-solid friction, which arose from the surface of the mercury in the trough. The resistance would not vary according to the revolutions. That was the difficulty of that meter.

Mr. GRAHAM was proceeding to ask the Witness to give descriptions of other meters, when Mr. MOULTON again objected.

Mr. GRAHAM said he wanted it on the notes.

His LORDSHIP said he rather objected. He knew very well why these things were wanted on the notes. They were wanted there in order to operate on the minds of the Court of Appeal. Counsel were practically masters of the situation, and knew so much more of these matters than he did, that it was very difficult for him to interfere effectively if that course was persevered in.

Mr. Moulton said it did not matter how the defendants got at their infringement. The question was was it an infringement?

Mr. Graham said if his Lordship examined the various stages of what Prof. Perry had done, he would see that there was nothing in common between what he had done and what the plaintiff claimed for.

His Lordship: I shall not interfere again. Unfortunately for me I feel the disadvantage of the position I am in more than I can express. Those who are addressing me and conducting the case have a knowledge of the subject matter, which it is impossible for me to arrive at, even after the very interesting lectures on electricity to which I have listened from counsel and witnesses. I must, therefore, leave myself in your hands.

Mr. Moulton: I submit that all this is irrevelant, and shall not cross-examine upon it.

His Lordship: I may say that is my opinion.

Witness, proceeding, said that in 1880 he took out a patent which showed a revolving armature and metal cup. He was proceeding to describe it, when

His Lordship said he must insist on his ruling. He was satisfied of the immateriality of the evidence.

Mr. Graham: Well, I will come to the conclusion (to Witness). You found you got a drag along the surface of the mercury which vitiated the efficiency of the instrument?—Yes.

And in order to get over that drag, did you wholly immerse the moving part in the mercury?—Yes.

And was the effect to get rid of the vitiating influence?—Yes.

When you had done that, you took out a patent for the motor meters which are now complained of?—Yes.

His Lordship: Is that the alleged infringement?—Witness: Yes, my lord.

Continuing, Witness said that by his invention the ratio of static friction at the driving parts was very greatly diminished.

Mr. Graham: In getting rid of these vitiating frictions, did you avail yourself of any information which appears in Hookham's specification?—No; not any.

Is there any information in that specification which points out how to get rid of these vitiating frictions in the way you got rid of them?—No, I think not.

And Hookham's meter has a wholly submerged brake?—Yes; it is made according to my 1891 patent.

Mr. Graham asked witness to describe the experiments which led to his discovering the quasi-solid friction on the surface of the mercury.

His Lordship: The question of how he arrived at his discovery is immaterial.

Mr. Moulton (to Witness): Prior to plaintiff's specification, did you ever know an electric motor meter with an electric brake in the market?—I don't think I did.

Mr. Bousfield: Did you ever conceive that you had borrowed from Mr. Hookham?—No. I never heard of Mr. Hookham until afterwards.

In answer to other questions, Witness said the Edison meter was an old meter, and would only work within a limited range. Still, it was not so very, very bad.

Prof. Silvanus Phillips Thompson: The principles on which the magnets in Hookham's meter were constructed were not at all new. They had been used for many years in motors and small magneto machines.

Witness, continuing, described the peculiarities of the Hookham motor meter. The motor in the defendant's meter differed on most main points from that of plaintiff's. Defendant's meter had no commutator, the currents being continuous. There was a great deal of what was common knowledge in Mr. Hookham's specification, and of what was known long before his specification was taken out. There were certain arrangements in other specifications for diminishing friction, which were equivalent to those used by Mr. Hookham. These and the commutator were not at all original. He produced various forms of commutators, and said that commutators dated back to 1837, Ritchie's being the first. He was examined at length as to various alleged anticipations.

Cross-examined by Mr. Moulton: Witness admitted that Mr. Hookham had adopted an ingenious device to avoid friction, but it was only a mechanical equivalent to what was contained in other meters. He did not know of such a device as Hookham's having been used before.

Re-examined: A many-turned armature was not a necessity, or essential to plaintiffs' instrument.

The case was again adjourned.

On Thursday further witnesses were called for the defendants.

Mr. John Imray, patent agent and consulting engineer, examined by Mr. Jenkins, said the value of the discovery of immersing a cup in mercury was, that there was scarcely any fluid resistance. The surface drag was always a difficulty when anything was moving through fluids. Surface tension was a power which all fluids have of sticking together at the surface more than elsewhere, and that was particularly so with mercury.

In your opinion, is the motor power of the defendant's meter substantially the same as the motor power in Hookham's?—It is a motor of a distinctly different type. I don't think any electrician would consider them the same. One is uni-polar and the other multi-polar. One has a commutator and the other no commutator. One reverses the current and the other does not. There is nothing like the cup in Perry's meter, which is described in plaintiff's specifications. With regard to the brake, I agree with previous evidence that it was perfectly well known in 1887 that Foucault currents produced a brake.

Does the defendant make use of that principle in the same way as plaintiff?—No; not in the same way.

Do you find anything in Hookham's specifications which would show you as a workman and an electrician how to make a brake like the defendants?—No; certainly not.

Proceeding, Witness said the grooves were different in both machines, and one had more pole-pieces than the other. The plaintiffs' were horse-shoe magnets, and the defendants' vertical magnets. There was nothing about permanent magnets in the original specification.

Prof. Ayrton, F.R.S., examined by Mr. Bousfield, said he was a joint patentee with Prof. Perry of the patent meter of 1882, known as the Perry meter. The specification described two forms of meter, a motor meter and a clock meter. The patent was taken out in 1882, but was not renewed in 1886 when it became renewable. They dropped it because there was no sale whatever for any kind of house supply meter. As regarded the motor meter, there was a difficulty with regard to the commutator, but it was one which they could have got over. Instead, they turned their attention to the clock meters, and advertised them for sale, but only two or three were sold, and the result was not sufficient to pay for the advertisements, much less for the patent, so they dropped it. The meters that were sold were disposed of to gentlemen, including Mr. Edison, who were interested in meters, and liked to know what the professors were doing. He had only about a dozen made, and advertised them in the years 1884 and 1885. M. Aron, in the meantime, had made a clock meter on which he afterwards paid a royalty to defendants on the meters he had sold whilst their patent was in force. The meter got into extensive use.

Mr. Bousfield: It is suggested that the speed of a meter like Hookham's should be about 200 revolutions of the disc per minute. Take the present Perry meter; what speed do you get in that?—From my own experiments, it makes for the smallest current one revolution in 17 seconds, and for the largest one in ·¾ of a second.

Mr. Moulton: It is not true in the least that the Hookham meter goes round 200 times a minute.

Witness, proceeding, said that Elihu Thomson's meter for the small current made one revolution in 44 seconds, and for the largest currents one revolution in 1·8 second. Experiments were at this stage made in the body of the Court with instruments showing the effects of fluid friction.

Witness, proceeding, said he had for many years past devoted himself largely to the construction of measuring instruments. Many of his instruments were well known to electrical engineers as standard instruments for measuring. The different types depended for their accuracy on the constancy of the permanent magnets he was using, and also on the strength of the permanent magnets. He described the construction of several of his and other instruments in order to show that much of what was contained in Mr. Hookham's specification was common knowledge, and that many parts of his instrument had been anticipated.

Mr. Bousfield, in the course of a warm argument with Mr. Moulton, said it appeared to him that the whole object of the plaintiff's claim was to prevent anybody else using a well-known principle.

Witness, in answer to a further question as to the practicability of Hookham's meter, said he was sure that such a meter as the original meter could not continue to register satisfactorily, because of the skin friction of the mercury, and because of the almost certainty that, if a current stronger than the meter could stand should pass through it, which was almost sure to happen, the mercury would be thrown out, and it would be of no use until the mercury was re-supplied. The use of grooves in magnets was a matter of common knowledge amongst electrical engineers. The meters of plaintiff and Prof. Perry were totally distinct. The motors used in each were essentially different. He was not interested in the Perry meter now, as his partnership with Prof. Perry ceased several years ago.

Cross-examined by Mr. Moulton: If magnets lost strength, they would not continue to be powerful.

You mean to say that if a powerful magnet loses some of its power, it is no longer powerful?—Not at the beginning; no, it does not cease to be powerful, but it is going on losing.

Will you show his Lordship any statement in electrical literature before the date of Mr. Hookham's patent, showing how you can get powerful constant magnets?—I do not know that the results and knowledge of instrument makers was put in a published form. With the exception of Jamin's investigations over several years, I am not aware.

Now, with regard to your patent of 1883. Is not that magnet of very minute power?—It is a small magnet.

Re-examined: In Prof. Perry's present form of meter, as well as in the plaintiffs', they had actually got a disc or cup totally immersed in mercury, and which rotated in mercury. He should say that the Foucault friction would be much greater than the fluid friction, and that there would be very little error in itself by the thing turning in mercury. Jamin found that by magnetising each steel spring separately—he did not put them together at all—he got a powerful magnet which did not deteriorate.

Mr. L. J. Steele, examined by Mr. Bousfield, said that he was an associate of the Institution of Electrical Engineers, had been electrician to the defendants for seven years, and had had nine years' experience in meters. In the Brillié meter a rotating magnet with fixed copper disc acted as a brake. The current of meter did not itself go through the motor. In the year 1886, he was interested in electrical work. At that time he knew that the effect of grooving the magnets was to produce eddy currents; it gave a retarding action. He had made experiments on the Edison meter in Court. The speed with 6 amperes through the armature was 240 revolutions a minute. He had tested the Hookham meter as to speed—that meter was labelled 20 amperes, and at 20 amperes the speed was about 330 revolutions a minute.

The hearing was again adjourned.

FRIDAY, MARCH 5TH.

Mr. LOUIS J. STEELE, cross-examined by Mr. FLETCHER MOULTON as to the Ayrton and Perry patent (No. 2,642, of 1882), said that it was no doubt essential in that specification that the current should go through the motor. He did represent that the Hookham 20-ampere meter which he tested was a very fair specimen, although it was a second-hand one.

His LORDSHIP: I cannot understand why, if you wanted to test Mr. Hookham's meter, you did not buy one.

Mr. BOUSFIELD: They had not been on sale for a long time, my Lord.

The WITNESS, in further cross-examination, said that before he tested the meter he had re-magnetised the magnets very strongly.

Mr. MOULTON: Twenty amperes going through, that shows two Board of Trade units in the hour?—It depends on voltage. The Board of Trade units depend on volts.

It therefore measures the current going through the armature?—Yes; but you are referring to Board of Trade units, and that is rather different to ampere hours.

When a 20-ampere current goes through that meter, the counter registers in the hour two, does it not?—At what voltage?

It does not make the slightest difference at what voltage?—Pardon me, it makes all the difference in the world. Board of Trade units depend on the voltage.

I have not said a word about Board of Trade voltage. I am putting it to you that a current of 20 amperes in an hour should register two on the dial?—I do not know what that means.

I have asked you whether it would not register two on the dial?

Mr. BOUSFIELD: Well, assume that it does.

Mr. MOULTON: I am putting it to the witness that when he tested the machine it was out of order, and registered 50 per cent. too much.

Mr. BOUSFIELD: If Mr. Steele had continued his experiments for an hour, running 20 amperes through, and had observed the numbers on the dial, he might then have come to the conclusion that the index on the dial showed that the number of rotations was not the proper number of rotations for 20 amperes.

The WITNESS, in re-examination, said that it was constantly part of his business to test a meter.

This evidence closed the defendants' case.

Mr. BOUSFIELD, in addressing his Lordship on behalf of the defendants, said that he was fully expecting his learned friend, Mr. Moulton, who had cross-examined the last witness, was going to ask permission to recall Mr. Swinburne, in order to minimise the value of Mr. Steele's evidence. Apparently, however, his learned friend had relied on his own energy and force in the statements he had made to his Lordship.

His LORDSHIP remarked that learned counsel in those cases were so much masters of the subject, that it seemed to be almost a matter of personal credit with them to beat the witnesses on points where they differed. The moment a scientific witness ventured on some statement with which learned counsel differed, however remote to the question at issue that statement might be, learned counsel seemed to think it a point of honour to thresh it out and best the witness if they could.

Mr. BOUSFIELD: Even a well trained dog sometimes starts off.

His LORDSHIP said that to his mind the most serious question in the case was the construction of the first claim. He thought it fair to say what was passing through his mind on that subject.

The following was the text of the first claim:—"An electricity meter for measuring currents, consisting of an electromotor with constant field arranged substantially as hereinbefore described and illustrated in the accompanying drawing, the said electromotor being combined with an electric brake also moving in a constant or nearly constant field, preferably the same field as that in which the armature rotates, substantially as herein described and illustrated in the accompanying drawings."

Mr. BOUSFIELD said that it might have been that Mr. Hookham, when he applied for his provisional protection, thought that he had invented a brand new thing. In construing what this particular claim was, effect must be given to the words, "arranged substantially as herein described and illustrated." The reason those words were put in was perfectly obvious. The patentee knew perfectly well that if he had not got words of that sort his claim might be construed to mean a claim to the Perry brake (1882 patent). Mr. Swinburne had admitted, in his evidence, that that was the first invention of a motor meter. If that was so, of course he (the learned counsel) should contend that that was an end of the question of infringement on the first claim. His submission was that Mr. Hookham was endeavouring to distinguish his brake simply by elements which were absolutely well known elements in order to make a good brake. He had never known, in all his experience, such a remarkable claim put before the Court as the plaintiffs' first claim. The Ayrton and Perry specification was in the same position as the Hookham, there being only one difficulty, and that was the question of friction. If Hookham had come in and solved that difficulty he would be entitled to his invention. But had he done that? That was the real question in the case. He (Mr. Bousfield) did not care what the claims were. Unless his Lordship could come to the conclusion that Hookham had given, in his specification, some practical directions which were unknown to electricians, and which the defendants had adopted in order to make their first inventions useful, or a success, there could be no infringement. According to Mr. Moulton's argument, anybody who had got an effective electric brake, and their magnets perfectly constant, would infringe the plaintiffs' patent. If that were the claim of the plaintiffs, he should contend it was one which could not be upheld. Everybody knew that it was essential to success to have the friction of the commutator as small as possible and the magnets constant. The only practical direction the plaintiffs had given which was of the slightest use to the defendants was as to having mercury contacts, and that was suggested by half a dozen other people. Passing on to the plaintiffs' sixth claim—viz., "Making grooves in the pole pieces of the electro-magnet, or permanent magnet, of an electricity meter for the purpose of increasing the action of the brake substantially as hereinbefore described and illustrated on the accompanying drawings," the learned counsel said that the substance of his argument would be that in the defendants' form of pole pieces they had not got the slightest idea from Mr. Hookham, and that they had only taken what was common electrical knowledge, and not in the slightest degree anything that Hookham had discovered, if he did discover it. He submitted that a man could not assume the position of making a detail an invention of itself, which he was entitled to a separate patent for, unless that invention was described in his provisional specification. He was then, of course, anticipating that his Lordship would find that the defendants had not infringed the first claim, in which case his learned friend, Mr. Moulton, was driven for success solely on the sixth claim. In that case he contended that the patent must be treated as if all the other claims were disclaimed. What did Mr. Hookham invent with reference to the grooving? He did not discover that the braking action depended upon the copper disc rotating in a field of varying magnetic intensity. That was developed by Faraday and others. It was the essential of a brake, and known to be the essential of a brake, and therefore the plaintiffs could not say that the defendants had infringed because they rotated in a field of varying magnetic intensity. What was it that the plaintiff had discovered as to that? He discovered that if he put grooves into the pole pieces locally, he would increase their braking action. Was that the same idea as duplicating the pole pieces? If it were, he had not discovered anything, because it was known. The details which Mr. Hookham had given were very small, and he (Mr. Bousfield) doubted very much whether he knew what he had discovered. The essential thing to have braking action was that the size of the grooves should be small compared with the air space. There was not, however, a word about that in the specification. Mr. Hookham found by rule of thumb that if he cut grooves in the pole pieces, he got better results. He submitted that there had been no infringement, and that his Lordship's judgment should be in favour of the defendants.

Mr. MOULTON, replying for the plaintiffs, said that when he came to review the evidence which had been adduced in that extremely long and interesting case, it was like counting the wounded after a battle. A large number of points had been started by the defendants, but he maintained that substantially his case had not been affected by the evidence. Taking it point by point, he thought that the accuracy and soundness of his opening statement had been substantially confirmed. That, however, did not dispose of the case. He stated at the commencement of the case that the theory of a meter with a magnetic brake was new, and he also told his Lordship that there had never been a practical meter of that kind until his client produced it; and also that no one before his client had ever shown how to produce at once a constant and powerful magnetic field, which was essential in order to make the meter accurate, because the inevitable static force which otherwise interfered with it could not otherwise be rendered inappreciable. He claimed that his statement as to the novelty of the invention was absolutely unshaken. They had had Prof. Perry, Prof. Ayrton, and Prof. Silvanus Thompson, all three most learned men, and thoroughly acquainted with all the literature of electricians, and he had challenged them formally to point to any statement in any mathematical books which showed that they could get, with regard to permanent magnets, at once intensity and permanence. Prof. Thompson said he could could not do so. Prof. Ayrton referred to French theories, and when he asked them if they could point to any use of such a magnet as that in any measuring instrument where constancy was necessary, they were obliged to say they could not. No person had been able to take up the challenge which he gave, and which was supported by the four witnesses whom he called. Mr. Hookham, Mr. Swinburne, Mr. Boyle and Mr. Dugald Clerk, all said that until his client took out his patent no person had shown how intensity was to be made compatible with constancy. As to the use of grooves in the magnets there was also a novelty, and he contended that the evidence showed that his client, Mr. Hookham, was the first person to make a really practicable motor meter. The so-called anticipations he also contended had all practically disappeared in the face of the evidence which he had been able to call. The conclusion upon the whole of the evidence was that Mr. Hookham was the first person to tell the world how to make an effective electric brake. The learned counsel's submission was that when his Lordship looked at the result of the evidence, examination-in-chief, and cross-examination, there was absolutely nothing to displace his statement that Mr. Hookham's was the first effective brake, and without an effective electric brake they could not get a meter. He thought his Lordship would find, after weighing the evidence which had been given, that the defendants had infringed both the first claim and the sixth claim, and that the plaintiffs' patent was valid as being the very first example of a constant field electromotor. The learned counsel concluded his address by thanking his Lordship on behalf of both parties for the patient manner in which he had listened to one of the most difficult and intricate cases with which he (Mr. Moulton) had ever had to deal.

His LORDSHIP replied that the case was a very intricate and difficult one, and far more so than the last case of the kind he had tried. He was afraid it would be some time before he would be able to deliver his judgment.

Judgment was accordingly reserved.

THE EDISON-BELL PHONOGRAPH COMPANY *v.* PROCTOR.

IN the Chancery Division, on Saturday, this case came before Mr Justice Wills, on a motion for judgment in default of defence. The action was for infringement of the plaintiffs' patents, and his Lordship made the customary order, with enquiry as to damages and costs.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1897.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents*, 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.*]

4,712. "Microphone worked by granular coal." J. O. Zwarg. Dated February 22nd.

4,734. "Improvements in or relating to the storage of acetylene gas." E. Barillot and C. C. Leclaire. Dated February 22nd.

4,755. "Improvements in electric motor propelled vehicles." H. G. Morris and P. G. Salom. Dated February 22nd.

4,810. "Improvements in or connected with apparatus for electrically illuminating and displaying letters, numerals, devices, and the like for advertising and decorative purposes." T. P. Martin. Dated February 23rd.

4,824. "Improvements in rail bonds for electric railways." F. H. Daniels. Dated February 23rd.

4,831. "Improvements in electric welding." G. W. de Tunzelmann and C. W. Baker. Dated February 23rd.

4,844. "Improvements in electric arc lamps." H. M. Darrah and W. J. Croft. Dated February 23rd.

4,871. "Improvements in apparatus for receiving and distributing audible sounds of messages sent by telephones or instruments of the like kind." J. Pullman. Dated February 23rd.

4,878. "Improvements in electric railway systems." C. F. de Redon. Dated February 23rd. (*Complete.*)

4,898. "Filaments for incandescence electric lamps." T. Balear. Dated February 23rd.

4,904. "Improvements in alternating current motors." W. L. Davies. Dated February 23rd.

4,916. "Improvements in electric accumulators." E. Heyl. Dated February 23rd.

4,934. "Improvements in electric arc lamps." H. Delevau and F. F. Brebat. Dated February 23rd. (*Complete.*)

4,979. "Improvements in station indicators for electric railways or tramways." J. Steffen. Dated February 24th. (*Complete.*)

4,981. "Automatic electro-photographic apparatus for the prevention of burglaries." C. Parodi. Dated February 24th. (*Complete.*)

4,993. "Improvements in apparatus for automatically cutting out electrical currents from dynamos when rising above or falling below a determined maximum or minimum and for gradually turning on such currents." E. L. Joseph. Dated February 24th. (*Complete.*)

4,994. "Portable electric lighting device." A. J. Boult. (H. C. Hubbell and T. F. Boland, United States.)

5,031. "Method and apparatus for seeing distant objects by electrical means." J. Szczepanik and L. Kleinberg. Dated February 24th.

5,040. "A new or improved telegraph relay suitable for long submarine cables." J. Rymer-Jones. Dated February 24th.

5,055. "Improvements in and relating to telegraphic transmitting apparatus." F. G. Creed. Dated February 25th.

5,100. "An apparatus for advertising or signalling purposes by means of electrically illuminated lamps." H. H. Pinches and F. Morley. Dated February 25th.

5,102. "Improvements in the construction of secondary batteries." W. S. Squire. Dated February 25th.

5,104. "Improvements in the method of insulating or covering electric cables, wires, or conductors, by means of dehydrated paper." W. Hepworth-Collins and T. Yates Nuttall. Dated February 25th.

5,105. "An improved paper specially adapted for insulating electrical cables, wires, conductors, storage batteries, and for other electrical insulating purposes." W. Hepworth Collins and T. Y. Nuttall. Dated February 25th.

5,129. "Improvements in dynamo-electric machines." G. L. Campbell. Dated February 25th.

5,131. "Improvements relating to electrical resistances." E. W. Bowles. Dated February 25th.

5,136. "Improved electric tan bark bath and apparatus therefor." J. J. Stanger. Dated February 25th.

5,157. "Improvements in electric arc lamps." W. J. Davy and G. T. Davies. Dated February 25th.

5,166. "Improvements in primary and secondary electric batteries." D. Neale. Dated February 26th.

5,171. "Improvements in electric conductors." W. Wood. Dated February 26th.

5,206. "Luminous electrical bell push." J. W. White. Dated February 26th.

5,222. "Improvements in electric wiring and in apparatus connected therewith." F. C. Raphael. Dated February 26th.

5,224. "Improvements in electric arc lamps." R. Gaynor. Dated February 26th.

5,237. "Improvements in the suspension of electrical accumulators or batteries on motor carriages." The Hon. R. T. D. Brougham and W. C. Bersey. Dated February 26th.

5,258. "Improvements in electrically propelled vehicles." L. Epstein. Dated February 26th. (*Complete*)

5,359. "Improved means for automatically effecting the shutting off of steam, or gas, or vapour engines, or for cutting off electric power from motor vehicles in cases of accidents." W. S. Simpson. Dated February 27th.

5,360. "A method of and apparatus for utilising electric energy." H. B. Cox. Dated February 27th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free*, 8½*d.* (*in stamps*).]

1896.

6,437. "Improvements in and relating to current collectors for electrically-actuated tramway vehicles on the conduit system." H. H. Lake. (Union Electricitäts Gesellschaft.) Dated March 23rd. Relates to current collectors for electrical trams running on the conduit system, and is to overcome the defect which ordinary collectors have of being broken when coming in contact with an impediment such as a stone or a piece of wood, &c. The device adopted to overcome this defect consists of a feeder having levers, whose extremities are pivotally arranged on bolts which lie at the corners of a parallelogram, so that the current collector is guided permanently parallel by the said levers. 4 claims.

7,896. "Improvements in electrical hair cutters and singer." F. M. Bell, J. L. Sloss. Dated April 14th, 1896. Relates to a method of cutting or singing hair. The invention consists of a wire of platinum stretched along the teeth of a comb, but not in contact with them. Each end of the wire is provided with electrical contact pieces insulated from the comb. The comb is brought near the hair, and when properly adjusted a current is passed through the wire, which is thereby rendered sufficiently hot to sever the hair, and thus the hair is effectually singed at the same time. 6 claims.

8,163. "A new or improved alarm clock and apparatus for automatically operating electric signals at definite hours." L. Mesmer-Webber. Dated April 17th, 1896. The invention consists of a clockwork operating outside the ordinary minute hand a rotary drum carrying a certain number of pins, which, by reason of the rotations of the drum, will press necessarily upon a corresponding number of contact springs, connected electrically to a corresponding number of metallic terminals arranged upon a dial plate of insulating material, thus establishing successively the electrical connections between the source of electricity, one of the poles of which is connected to the said drum and the said terminals, which may be connected to the electric bell in the different chambers, the second conductor of the said bells being connected to the second pole of the source of electricity. When the minute hand of the clock indicates the hour corresponding to the terminal connected to the bell in the room in which the guest must be called, this bell will be set in action by the contact of the corresponding pin on the drum with its contact spring. 2 claims.

8,382. "Improvements in or relating to automatic circuit-breakers, for use in electric tramcars or other electrically-propelled vehicles." J. Devonshire. (W. B. Potter.) Dated April 21st, 1896. Relates to circuit-breakers specially adapted for use on electric tramcars, in which a separate automatic circuit-breaker is associated with each controller, the two circuit-breakers being connected in the circuit in parallel. It is the purpose of the invention to provide for two circuit-breakers thus situated a single interchangeable handle, which can be removed only when the circuit-breaker is open, so that the motorman, in going from one end of the car to the other, must remove the handle, and thus open the circuit at one end before he can close the circuit-breaker at the other end to operate the controller. 7 claims.

10,047. "System and means for electrical transportation." P. H. Stern. Dated May 12th, 1896. Relates to an improvement in electrical transportation, and consists in arranging along the line of travel primary coils, which are energised by a pulsating current, preferably in the form of a polyphase current, which influences the armature mounted on the vehicle travelling along the route, the passage of the pulsating current through the primary coil sets up a magnetic field, which, by the nature of the current and the electrical connection, is constantly changing, both in intensity and direction. The field thus set up acts by induction upon the motor element carried by the vehicle, causing said motor element to rotate and thus propel the vehicle. 9 claims.

10,096. "Improvements in arc electric lamps." A. O. Mackin. Dated May 12th, 1896. Relates to a self-trimming magazine lamp. The magazine contains a number of carbons which are necessively fed into operation automatically, the lower or negative carbon being released and dropped out when the positive carbon has been fed and burned to a certain point, the positive carbon being at the same time released and dropped into the negative holder, where it is caught and held, while a new carbon is fed from the magazine into the positive holder. This action is repeated until the carbons are exhausted from the magazine. 3 claims.

10,772. "Improvements in starting and stopping devices for electrically operated elevators." Otis Elevator Company, Limited. (Otis Bros. & Co.) Dated May 19th, 1896. Relates to an electric automatic stop device for use in connection with electric elevators, and has for its object to provide means whereby the motor operating the elevator may be stopped or controlled automatically when through any cause the operator fails to properly manipulate the controlling devices. 13 claims.

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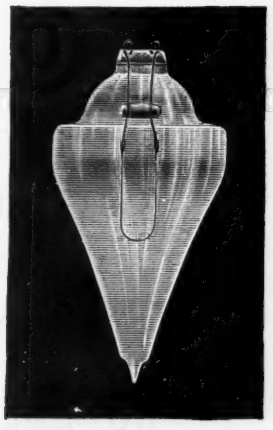

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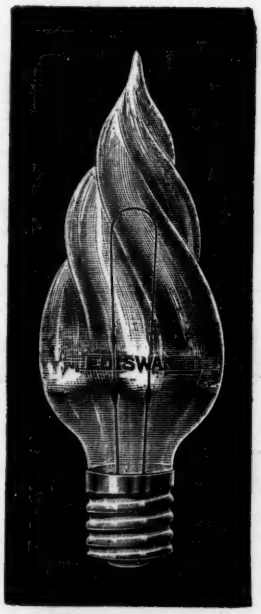

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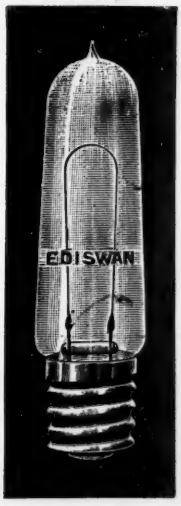

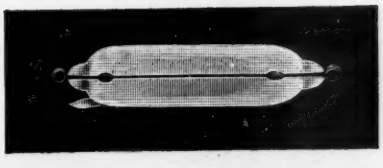

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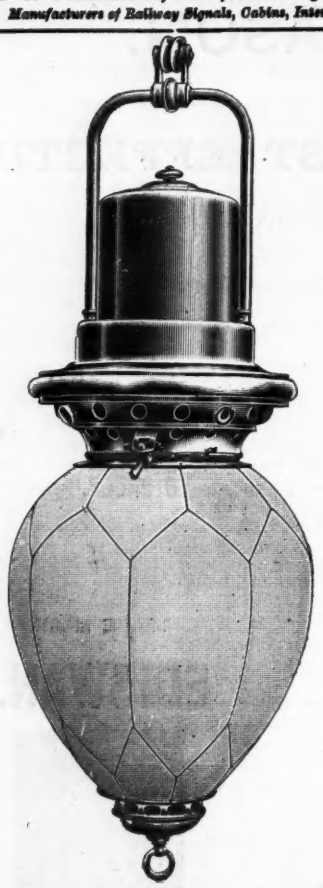

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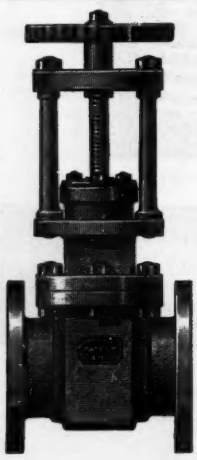

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